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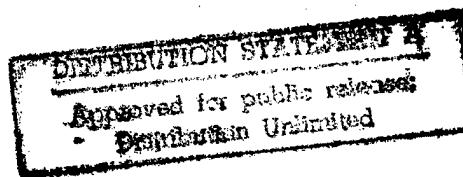
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# USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 101



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23 March 1983

USSR REPORT  
ELECTRONICS AND ELECTRICAL ENGINEERING

No. 101

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AEROSPACE & ELECTRONIC SYSTEMS

UDC 621.396.019.4

OPTIMALITY OF MEASURING NAVIGATION PARAMETERS ON BASIS OF SIGNALS FROM  
DIFFERENCE-TYPE RANGE MEASURING SYSTEMS

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 14 Oct 81)  
pp 38-42

RYABTSOV, A. L. and BOLDIN, V. A.

[Abstract] Reception and processing of radio signals from difference-type (hyperbolic) range measuring systems are considered, specifically optimal algorithms which us a priori information about the input parameters. Two ways of representing the state vector (vector of signal parameters to be estimated) for synthesis of optimum nonlinear Markov filters are compared, with the signal described as  $s(t) = \sum_{i=1}^n A_i f(t' - T_i) \cos[\omega_0(t' - T_i) + \varphi_i]$  or as  $s(t) = A_1 f(t' - T_1) \cos[\omega_0(t' - T_1) + \varphi_1] + A_2 f(t' - T_2 - \tau_d) \cos[\omega_0(t' - T_1 - \tau_d) + \varphi_2]$  (where  $\tau_d = T_2 - T_1$ ) in an additive mixture of signal and noise. The first representation is found to result in a structurally simpler optimum navigational signal receiver and processor. Figures 1; references 4: Russian. [101-2415]

UDC 621.396.9:629.7.05

OPTIMAL OUTFITTING OF MEASURING INSTRUMENTS IN RADIOTECHNICAL SYSTEMS FOR  
SHORT-RANGE NAVIGATION

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 21 Dec 81)  
pp 22-32

YARLYKOV, M. S. and ARTEMENKOV, V. S.

[Abstract] A problem of short-range navigation, namely optimal outfitting of the measuring instruments in the radiotechnical system, is approached through synthesis of the receiver for optimal complex processing of signals in accordance with the Markov theory of nonlinear estimation and filtration. Range and azimuth readings are represented as a two-component vector-function,

one component being a radio pulse signal with unknown arrival time and random phase and the other component being a low-frequency random process to which wind velocity measurements have been converted. For simplification, fluctuations of the delay of responder-beacon signals and local rereflections of signals are disregarded. The problem is formulated in terms of transformation of signal and interference between input and output of the receiver during time interval  $(t_0, t)$ . The equations of optimal processing have been solved by the Runge-Kutta on a digital computer, separately for the range channel and the azimuth channel. Accuracy and interference immunity are estimated on this basis. The two discrimination characteristics of a completely outfitted radio-technical short-range navigation system are also evaluated, one characterizing the time discriminator in the channel with a phase detector and one characterizing the time discriminator in the channel with a synchronous detector. Figures 6; references 9: 8 Russian, 1 Western (in translation).

[101-2415]

#### DETERMINATION OF DATA FOR RADIO OPERATION VIA SATELLITE

Moscow RADIO in Russian No 6, Jun 82 p 7

DOBROZHANSKIY, V.

[Abstract] Input data for radio operation via satellite, namely tables of monitoring orbits for each satellite, are published in the "Radio Amateur Satellites in Flight" column of the "Sovetskiy Patriot" newspaper. These data include orbit number with time and length of the first ascending module each day. With the aid of these tables all calculations and corrections necessary for determining the visibility zones and establishing communication links between radio operators can be made. There is space provided in these tables for entering operators' comments pertaining to accuracy and reliability of the data. Tables 4.

[118-2415]

ANTENNAS & PROPAGATION

UDC 523.164.8

RADIO-WAVE PROBING OF ATMOSPHERE WITH USE OF ARTIFICIAL AND NATURAL SIGNAL SOURCES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 25 Sep 81) pp 2310-2317

KOLOSOV, M. A. and PAVEL'YEV, A. G.

[Abstract] Radio-wave probing of the atmosphere is a rather new method of exploring the atmosphere above a certain region on earth, with a stationary observation point located at the center of this region on the ground and with sources of electromagnetic waves located in space. Such sources can be either transmitted mounted on mobile craft (airplanes, satellites) or compact natural ones (stars, quasars, pulsars, cosmic masers). The basic principles of this method derive from the dependence of the refraction angle, which characterizes the curvature of wave trajectories, on the apparent elevation angle or the aiming distance of the signal source. Both parameters are functions of time, they are related to one another through an equation of geometrical optics and through the Doppler frequency or the amplitude of the signal wave. It is thus possible, by calculation and measurement, to solve the reverse problem: determine the altitudinal profile of the refractive index and that of its altitudinal gradient from the known dependence of the refraction angle and of its derivative (with respect to the aiming distance) on the aiming distance. This is demonstrated here on an example of an analytical solution for the troposphere, with the regularizing feature that small deviations in experimental data correspond to small deviations in the sought profile. The accuracy of the solution, based on the assumption of a spherically laminar and spherically symmetric atmosphere, depends on the accuracy of Doppler measurements. Figures 2; references 10: 9 Russian, 1 Western (in translation).  
[117-2415]

UDC 535.42:534.321.9

DIFFRACTION OF LIGHT BY ULTRASONIC SIGNAL WITH LINEAR FREQUENCY MODULATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 2 Feb 81) pp 1835-1837

VASIL'YEV, Yu. G. and SHABANOV, N. S.

[Abstract] Ultrasonic signals with linear frequency modulation are used for processing wideband radio signals. Here the problem of diffraction of light by such a signal is solved by the method of perturbations. The optical field within the acoustooptic interaction space and farther from the light focusing plane is calculated for a plane incident light wave interacting with a sound signal of unit amplitude and duration  $\tau$ . The condition of quasi-steadiness is used and only first orders of diffraction are considered. Expressions are derived for the intensity of diffracted light, taking into account departure from the Bragg condition at signal frequencies other than the carrier frequency. The expressions become simpler for the special cases of high-frequency signals and narrow-band signals. References 7: 6 Russian, 1 Western.

[103-2415]

UDC 537.8:53.072.51

MATHEMATICAL MODELING OF AXISYMMETRIC FIELDS BY METHOD OF SMALLEST AUTONOMOUS MODULES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 30 Dec 81) pp 2333-2342

NIKOL'SKIY, V. V. and NIKOL'SKAYA, T. I.

[Abstract] The original method of smallest autonomous modules, developed for mathematical modeling of axisymmetric fields, is modified by replacement of parallelepipeds in a rectangular system of coordinates with rings in a cylindrical system of coordinates. Along the field axis these rings degenerate into solid cylindrical regions. The scattering matrix for a smallest autonomous ring module is constructed in a "natural" basis, namely regarding the virtual channels as degenerate physically realizable waveguides, although various other basis are also suitable for this purpose. With this apparatus available, several problems of diffraction are easily solved for a combination of coaxial transmission line and circular waveguide. The algorithm of discretization of the incident wave with a  $u^+ = (kr)^{-1}$  radial profile takes into consideration that a T-mode is fundamental in a coaxial line. Coefficients of the scattering matrix are calculated for a shoulder (stepwise change of diameter) along the inner conductor of the coaxial line, for a support washer inside the coaxial line, for the transition from coaxial line to circular waveguide, and for a dielectric passive or active element in a discontinuity along the coaxial line. Figures 13; references 9: Russian.

[117-2415]

UDC 537.874.4

SCATTERING OF PLANE WAVE BY SOLIDS OF REVOLUTION WITH ABSORBING COATINGS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 27 Mar 81) pp 2101-2109

ARSAEV, I. Ye.

[Abstract] The problem of scattering of plane waves by a body with a somewhat arbitrary shape of the enveloping surface and with a coating is solved by the method of geometrical optics in the zeroth-order approximation (radii of body and coating curvatures much larger than the wavelength). The solution is sought in the form of a series, with a recurrence relation for calculating any term, each term representing a ray multiply reflected in the coating. The body is assumed to be a solid of revolution, the coating is assumed to be homogeneous with complex dielectric permittivity and magnetic permeability. The solution to the scalar problem, sum of two rays, is extended to the vector case. The method of geometric optics is not applicable and must be modified when the derivative of the exit angle with respect to the transverse coordinate approaches zero for any ray. As a special case is considered backscattering. For bodies and coatings with small radii of curvature, approaching the wavelength and resonance conditions, the problem can be solved by asymptotic methods. The accuracy of numerically obtained solutions is estimated by comparing them with the exact solution in Mie series for a metal sphere with dielectric coating. Figures 6; references 9: 3 Russian, 6 Western (2 in translation).

[116-2415]

UDC 537.874.6

SCATTERING OF ELECTROMAGNETIC WAVE BY FINITE ARRAY OF IDEALLY CONDUCTING RODS WITH DIELECTRIC DIAPHRAGMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 4 Feb 80, after correction 24 Jun 81) pp 1726-1734

SUKHAREVSKIY, O. I.

[Abstract] The two-dimensional antenna problem of diffraction with scattering is solved for a finite array of ideally conducting parallel rods separated by dielectric diaphragms. The currents on the former and the fields in the latter are described by a system of simultaneous integral equations. These have been solved numerically for scattering of a primary wave with E-polarization by a synphasal antenna array with protective housing. The metal rods were assumed to have circular cross sections with a radius equal to a fraction of the wavelength and much larger than the thickness of the dielectric diaphragms, the distances between rods being equal to several wavelengths and the array forming a circle with a still larger radius. Calculations were started for an antenna array without diaphragms. The radiation pattern was obtained as a result. Figures 7; references 6: 5 Russian, 1 Western.

[103-2415]

EFFECT OF COMPENSATION OF WAVE DISTORTIONS CAUSED BY SCATTERING IN NON-HOMOGENEOUS MEDIUM BY MEANS OF WAVEFRONT INVERTING MIRROR

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 4 Feb 81) pp 1691-1698

SAICHEV, A. I.

[Abstract] Wavefront inversion by means of a mirror is considered as a method of optimally focusing radiation in a nonhomogeneous medium. Conditions are established under which the intensity of reflected waves duplicates that of incident waves even in the presence of small-scale inhomogeneities with appreciable backscattering. The analysis begins with reflection of a scalar monochromatic wave with complex amplitude by a layer of a nonhomogeneous medium bounded by a wavefront inverting mirror and solution of the corresponding equations in the Fresnel approximation. The layer is then considered to be randomly small-scale nonhomogeneous with a uniform reflection coefficient  $|R| \leq 1$ , and energy relations are established in the diffusion approximation. Next the finiteness of mirror dimensions and nonuniformity of the reflection coefficient are taken into account, with the assumption that the mirror area is larger than the brightness spot of incident radiation. The statistical characteristics of plane normally incident waves are evaluated, although mirrors utilizing nonlinear optical processes invert least efficiently the fronts of such waves, because the results are most elucidating with regard to the nature of exponential intensity buildup and reveal the necessity for refining the treatment of a wavefront inverting mirror as a flexible metal mirror. On this basis is then evaluated the role of such a mirror in compensating the distortions in reflected waves caused by inhomogeneities in the medium. Efficient compensation is found to require a mirror radius much larger than the statistical beam width and the mean reflected field is found to restore the form of the incident wave more effectively in a randomly nonhomogeneous medium than in a homogeneous one. In extending the analysis to pulses of quasi-monochromatic or nonmonochromatic waves, not only their space-time characteristics but also the pulse duration and the fluctuation of their arrival time are taken into account. The author thanks A. A. Betin, S. N. Gurbatov, A. N. Malakhov and G. A. Pasmanik for helpful discussions of the results.

References: 9 Russian.

[103-2415]

UDC 621.371:537.874.6

DIFFRACTION OF ELECTROMAGNETIC WAVES BY PERIODIC SCREEN WITH HOLES OF ARBITRARY SHAPE

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 6 Aug 81)  
pp 32-37

KAPLUN, V. A., KRAVCHENKO, I. T. and TSARYUK, D. A.

[Abstract] The problem of diffraction of plane electromagnetic microwaves is solved for an infinitely large metal screen of finite thickness with periodically spaced identical holes of arbitrary shape, these holes being filled with one dielectric material and the entire screen also coated over the holes with a thin layer of another dielectric material on the front side only. The problem is solved by the method of cross sections, after the system has been subdivided into four distinct regions (holes with dielectric filler, metal webbing, dielectric coating on front side, half-space on back side) and with the Floquet condition of quasi-periodicity of plane waves satisfied. The corresponding field equations of the boundary-value problem are reduced to a system of differential equations for the webbing with appropriate boundary conditions for the E-components and the H-components, which yield the coefficients in the solution sought in the form of series. Typical numerical data on the power transmission characteristic of screens with rectangular holes and screens with cloverleaf holes agree closely with experimental data.

Figures 5; references 7: 5 Russian, 2 Western.

[101-2415]

UDC 621.371:551.510.511.6

FREQUENCY FLUCTUATIONS OF RADIO WAVES PROPAGATING THROUGH TURBULENT ATMOSPHERE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 4 May 81) pp 1683-1690

ARMAND, N. A.

[Abstract] Frequency fluctuations of radio waves propagating through a turbulent atmosphere are analyzed from the standpoint of their effect on measurement accuracy. Inasmuch as these fluctuations are mostly associated with the small-scale part of the space spectrum (size distribution) of inhomogeneities, the external scale as well as the internal scale are considered, their respective roles depending on the magnitude of the spectral inhomogeneity index. Fundamental relations are derived for the intensity of frequency fluctuations in a dielectric medium, frequency being regarded as the time derivative of the phase and its fluctuations as those of a random function. Calculations involving degenerate hypergeometric series with gamma-functions for a Fresnel zone much wider than the internal scale of inhomogeneities lead to estimates applicable to the troposphere of planets and measurements within the solar system. Formulas are derived and numerical data are

obtained for measurements with a linear antenna when inhomogeneities propagate in the direction parallel to the latter. The accuracy of these measurements is estimated and found to be greatly improved with an averaging time much longer than the length of the internal scale divided by the velocity of the inhomogeneities, inasmuch as the effect of small-scale turbulence becomes smoothed out and the frequency fluctuations become less intense. The author thanks A. I. Yefimov for assistance in collating the material, as well as A. I. Yefimov and A. N. Lomakin for numerous discussions of the results. Tables 1; references 17: 9 Russian, 8 Western (1 in translation). [103-2415]

UDC 621.372.8.049.75

QUASI-T-MODE WAVES IN DEVICES ON COUPLED STRIP LINES WITH UNBALANCED ELECTROMAGNETIC COUPLING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 14 Jan 81) pp 1711-1718

VOROB'YEV, P. A., MALYUTIN, N. D. and FEDOROV, V. N.

[Abstract] Wave processes in coupled strip lines with unbalanced electromagnetic coupling are analyzed by the classical method of matrix calculus. Voltage and current equations are solved for the equivalent eight-pole network with a source impedance at one end of one line and load impedances at its other end and at both ends of the other line. Into account are taken fast and slow incident waves as well as fast and slow reflected waves. The power flowing in both directions is also calculated. The results reveal the mechanism by which phase velocity and group velocity are controlled. Numerical data for a coupled pair of meander line and solid strip with typical values of inductance and capacitance per unit length, obtained by computer calculations according to program written in ALGOL with an ALFA translator and including frequency characteristics of the voltage moduli, agree closely with experimental data. The results can be useful for design purposes. Figures 8; references 17: 11 Russian, 6 Western (1 in translation). [103-2415]

UDC 621.391

ACCURACY OF ESTIMATING COORDINATES OF POINT TARGET AND THEIR DERIVATIVES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 13 Dec 79, after correction 25 Jan 82) pp 1746-1753

NAKHMANSON, G. S.

[Abstract] A receiver antenna array of arbitrary geometry is considered which tracks a moving point target. The accuracy of simultaneous estimates of target

coordinates and their derivatives is evaluated, assuming that the motion of the target remains uniform during the probing period. Estimates are based on maximum likelihood, the optimum receiver generating an output signal proportional to the likelihood functional. Calculations are made for a target in the far field or in the Fresnel zone and in each case the conditions for maximum attainable accuracy are established, in terms of antenna aperture, width of signal frequency spectrum, and signal-to-noise ratio, considering a probing signal with linear frequency modulation and bell-curve envelope. Figures 5; references 7: Russian.

[103-2415]

UDC 621.391

DETECTION AND RECEPTION OF COMPLEX SIGNALS MASKED BY NOISE AND BY INTERFERENCE WITH DISCRETE SPECTRUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 24 Mar 80, after correction 7 Dec 81) pp 1762-1772

ULANOV, A. Ye., SHAYDUROV, G. Ya. and GRISHKO, N. I.

[Abstract] An optimum receiver is synthesized for detection and filtration of complex signals masked by both noise and interference, the latter having a discrete spectrum. The method of synthesis is based on space-time representation of the input process and use of a priori information about the interference spectrum, assuming the noise to be Gaussian. Noncorrelation between sample values is replaced with their independence and each component of the input process is expanded into a Taylor series, taking into account the smallness of the useful signal. The latter and the reference signal are each characterized as quasi-harmonic oscillations with a carrier frequency and with phase and envelope both functions of time. Simulation leads to the optimum receiver, which consists of a number of contiguous frequency channels equal to the number of interference frequency bands. Each channel includes a bandpass input filter, a noninductive nonlinear element, and a bandpass output filter matched to the corresponding signal component. It is expedient to add the outputs of all output filters coherently at the radio frequency and to convert the weighted sum in a single filter matched to the entire signal and feeding a voltage signal to the resolver. Mean value and dispersion of this voltage are calculated with signal present and with signal absent, respectively. The condition for maximum signal-to-interference ratio at the receiver output is established with the aid of the Schwarz-Bunyakovskiy inequality, the detection characteristics (false-alarm probability and correct-detection probability) are determined in accordance with the Neyman-Pearson criterion. The interference immunity of a nonlinear filter and of a quasi-optimum receiver is then evaluated for the case of non-Gaussian interference in the form of frequency- or phase-modulated oscillations with unknown initial phase. Figures 7; references 6: Russian.

[103-2415]

UDC 621.391

SIMULTANEOUS DETECTION, RESOLUTION, AND MEASUREMENT OF SIGNALS SUBMERGED IN BACKGROUND INTERFERENCE AT OUTPUT OF ANTENNA ARRAY: SYNTHESIS OF ALGORITHM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 8 Apr 81) pp 2179-2184

SHINAKOV, Yu. S. and SPERANSKIY, V. S.

[Abstract] A linear antenna array containing  $K$  equidistant but not necessarily parallel receivers is considered for simultaneous detection, resolution, and measurement of signals coming together from  $M$  sources and submerged in background interference. This interference is assumed to be additive and represent a Gaussian process. Noise is assumed to be an independent random process with the same probability characteristics in each channel. The phase front of a signal wave from any source is assumed to be locally plane. An algorithm of simultaneous signal detection, resolution, and measurement (estimation of parameters) is constructed according to the maximum-likelihood principle. Included in the estimation are the number of signals, a discrete parameter, and the angular coordinates of their sources. The algorithm of estimating the signal parameters is presented in a form suitable for implementation on a digital computer or a special-purpose calculator. References 8: 5 Russian, 3 Western. [116-2415]

UDC 621.391.253

ORTHOGONAL SEQUENCES BASED ON FULL CODE RINGS AND THEIR CORRELATION CHARACTERISTICS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 6 May 80) pp 1773-1778

BEL'TYUKOV, V. V. and SIVOV, V. A.

[Abstract] The properties of orthogonal code sequences based on full code rings derive from three theorems and one corollary concerning such sequences, their permutations and  $m$ -dimensional vector space of volume  $V = 2^m$ . The formation of such sequences by means of shift registers with nonlinear feedback is considered, recurrent sequences on nonlinear Boolean functions being of particular interest. Their correlation characteristics, namely statistics of their autocorrelation and crosscorrelation functions have been evaluated by numerical analysis using the algorithm of fast Fourier transformation. They include mathematical expectation of lateral overshoots, mean mathematical expectation of overshoots, dispersion of lateral overshoots, mean dispersion of overshoots, and mean maximum overshoot. They are compared with those of other sequences, specifically Gold sequences and nonlinear derivative ones. Tables 5; references 6: 4 Russian, 2 Western (1 in translation). [103-2415]

UDC 621.396.67.01

FORMATION OF THREE-DIMENSIONAL IMAGES IN MICROWAVE AND ULTRASONIC RANGES BY MEANS OF ANTENNAS WITH BEAM OSCILLATION DURING PULSE

Moscow RADIOTEKHNika I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 9 Jul 81) pp 1699-1705

GINZBURG, V. M.

[Abstract] Formation of three-dimensional images of stationary or moving objects with microwaves or ultrasonic waves is described, the method involving the use of pulsed radiation sources and antennas with beams which oscillate over a period comparable with the duration of a radiation pulse. The outstanding feature of this method is conversion of signals in the time domain to quasi-interference patterns in the space domain with which contours of objects can be measured. The principle of this method is demonstrated on the simple case of rectangular radiation pulses and linear beam oscillations. Identical oscillations in the transmission mode and in the reception mode are assumed, but the principle can be extended to different beam oscillations in each mode. An antenna system has been designed to operate with linearly frequency-modulated bell-shape pulses and frequency-sensitive beam oscillation. It includes a pulse generator, generators of two weight functions, an adder, two multipliers, filters, an integrator, a synchronizer, and a resolver. It can also include a modulator of transmitted radiation pulses. The signal-to-noise ratio at the resolver input is calculated with the aid of the Bunyakovskiy-Schwarz relation and found to be a periodic space function alternating between peaks and nulls with a period equal to half the wavelength of signals generated to control the beam oscillations. Figures 3; references 12: 8 Russian, 4 Western (1 in translation).

[103-2415]

UDC 621.396.67.01

ATTAINABLE CAPABILITIES OF ANTENNAS IN TERMS OF DIRECTIONAL CHARACTERISTICS AND FIELD ATTENUATION IN SHADOW ZONE

Moscow RADIOTEKHNika I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 19 Jan 81) pp 2350-2355

POLISHCHUK, I. M.

[Abstract] The attainable capabilities of antennas are evaluated from the standpoint of directional characteristics and field attenuation in the shadow zone. As a simple example is considered a two-dimensional antenna with a radiating aperture surrounded by an ideally conducting circular cylinder which contains all radiator elements. The analysis is based on a theorem pertaining to a partial antenna array complete within a  $(-\pi, \pi)$  space. The directional

characteristics are then related to electromagnetic compatibility and the necessary field distribution in the antenna aperture is determined which will optimize these characteristics and simultaneously minimize the field intensity in the shadow zone. Figures 3; references 10: 8 Russian, 2 Western (in translation).

[117-2415]

UDC 621.396.67.01

#### SYNTHESIS OF ANTENNAS FOR MAXIMUM DIRECTIVE GAIN

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 15 Mar 82) pp 2094-2100

FEL'D, Ya. N.

[Abstract] An antenna is synthesized not for a given radiation pattern, but for maximum directive gain in a certain direction stipulated in a spherical system of coordinates with the origin at the center of the space occupied by the antenna. The procedure involves determining the optimum distribution of electric currents which will ensure the maximum directive gain, based on rigorous solution of the corresponding diffraction problem. The method is first applied to an antenna whose aperture covers an ideally conducting metal horn surface. The distributions of both electric field and magnetic field, and then the directive gain, are calculated in the Kirchhoff approximation. In the second variant of the problem the horn surface is not assumed to be ideally conducting but the fields are added synphasally. In the third variant the relation between the tangential field components is assumed to be such as for a locally plane wave. Figures 1; references: 4 Russian.

[116-2415]

UDC 621.396.67.01.05

#### ANTENNAS IN CONDUCTING MEDIA (REVIEW)

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 15 Oct 80) pp 2065-2093

KARNISHIN, V. V. and AKINDINOV, V. V.

[Abstract] Results of experimental and theoretical studies made during the past 3 decades concerning antennas in conducting media are summarized systematically and comprehensively. The review covers basic principles and characteristics (input impedance, radiation pattern, current distribution, wave propagation constant, and their frequency dependence) of a linear antenna not insulated from the ambient medium, a linear antenna completely insulated

from the ambient medium, and an insulated linear antenna with grounded (water immersed) terminals or concentrated loads at the ends. This last type of antenna is usually a cable with bare ends and most often shorted at the ends, difficult to analyze because of discrepancies between theoretical and experimental data. The conducting medium can be homogeneous, laminar or otherwise nonhomogeneous, also either absorbing or nonabsorbing. Antennas completely insulated from the conducting ambient medium feature high losses in the near-field zone and poor selective frequency characteristics. The review covers also loop antennas, insulated ones and bare (not insulated) one, with or without magnetic core inside and with or without surrounding spherical air sheath. It presents the results of analytical calculations and includes description of experimental techniques such as use of probes (e.g., superconducting quantum interference devices) and special instruments (vector voltmeters, attenuators, frequency meters). Further research still needed is in the area of engineering theory and design, especially pertaining to bare (not insulated) antennas in electrically leaky media, also in the area of comparative evaluation for selection and application purposes. The authors thank M. A. Kolosov and P. Ya. Ufimtsev for their interest, and O. S. Gashevskaya, T. N. Kosyatova, T. D. Sidorova and M. A. Nadeyev for their assistance in formulating this review. Figures 17; references 71: 15 Russian, 56 Western.

[116-2415]

UDC 621.396.67.012.12

#### OPTIMIZATION PROBLEM ASSOCIATED WITH PENCIL-BEAM ANTENNA SYNTHESIS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian  
No 4, Jul-Aug 82 (manuscript received 22 Jun 81) pp 44-50

MALOZEMOVA, L. K. and KHURGIN, I. M., Leningrad

[Abstract] Some problems in radio involve minimizing the maximum absolute value of a complex function with respect to linear parameters. These problems can be numerically solved in two stages: 1) Finding the parameters that minimize combined deviation of the real and imaginary parts of the criterion functional from zero; and 2) Using a linearization method to transform the resultant solution to a global solution of the initial problem. The authors apply this method to the problem of synthesizing pencil-beam antennas: finding the field distribution in the antenna aperture that corresponds to the minimum level of the polar pattern in the side lobe region. The polar pattern is a complex function represented as a linear combination of partial patterns. The problem of synthesis is then formulated as a convex minimax problem, the real and imaginary parts of the polar pattern being linearly dependent on the undetermined coefficients. It is shown that the solution is satisfactory even on the first stage. Figures 3; references 8: 5 Russian, 3 Western.

[60-6610]

UDC 621.396.96:391.26.01

GAME-THEORY APPROACH TO DETECTION OF RADAR SIGNALS MASKED BY UNKNOWN BACKGROUND INTERFERENCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 17 Mar 80) pp 1754-1761

RODIONOV, V. V.

[Abstract] A minimax detector of radar signals is synthesized from the stand-point of game theory, assuming that the signals are masked by Gaussian interference with limited average power. As the optimality criterion for evaluating the strategies of both players (radar system and interference generator) is selected the signal-to-noise ratio at the output of the optimum receiver, considering that the detection quality in this case is a monotonically increasing function of the latter. The optimum strategy of each player is found from the solution to the game problem for the payoff function, under given constraints on form of the probing signal and on possible jamming modes (series of orthogonal functions and their coefficients). The guaranteed signal-to-interference ratio is established for a radar system which uses any pure strategy (any kind of probing signal) and the interference immunity of a radar system is found to increase with use of mixed strategy involving random selection of the probing signal. Presence of white noise is also considered, maximum interference immunity in this case being ensured by use of orthogonal signals or signals forming a spherical surface in the corresponding  $m$ -dimensional Hilbert space. The optimum strategy of a radar system is determined for two cases: the set of probing signals  $s(t,a)$  ( $a \in A$ ) parametrized so as to make  $A$  a compact in an  $n$ -dimensional Euclidean space or so as to make  $A$  a discrete set. References 8: 5 Russian, 3 Western (2 in translation).

[103-2415]

UDC 621.396.677.49.01

DIFFERENCE RADIATION PATTERNS OF ANTENNA ARRAYS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 2 Jun 81) pp 2356-2361

PAVLYUK, V. A. and RYBALKO, A. M.

[Abstract] Synthesis of a difference radiation pattern with antenna arrays of arbitrary geometry is considered, taking into account field fluctuations in the aperture and presence of passive elements as well as conditions for suppression of side lobes. The problem is solved by minimization of the functional  $\phi(I) =$

$$M \left( \int_0^{2\pi} \int_0^\pi |F_0(u) - \vec{F}_s(u)|^2 \sin\theta d\theta \right)^2 d\Omega = \int_{\Omega} |F_0(u)|^2 d\Omega - 2\operatorname{Re}(I, \tilde{F}_0) + (H, I)$$

( $I$ -nominal vector of excitation currents,  $M$ - mathematical expectation,  $F_0(u)$ - required radiation pattern,  $\vec{F}_s(u)$ - actual radiation pattern,  $H$ - Hermitian of

mutual impedances with stochasticity of radiation pattern taken into account), i.e., its optimization with respect to current distribution. Calculations have been made and random errors estimated for a linear equidistant antenna array with  $N < 12$  isotropic elements and with various reactive loads. The optimum load impedance has been determined for the closest spacing of array elements such that further decreasing the distance between them will not yield further advantage. Figures 4; references: 7 Russian.

[117-2415]

UDC 681.787:681.7.068.4

SMOOTHING FLICKER OF OUTPUT SIGNAL FROM FIBER-OPTICAL RING INTERFEROMETER CAUSED BY INSTABILITY OF PARAMETERS OF SINGLE-MODE FIBER-OPTICAL LIGHTGUIDE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 15 Jun 81) pp 2245-2246

BAZAROV, Ye. N., KOVALENKO, V. G., POLUKHIN, A. T., SVERCHKOV, Ye. I. and TELEGIN, G. I.

[Abstract] The output signal from a fiber-optical ring interferometer is produced by interference of two opposing waves and its characteristics depend not only on the phase difference between these waves but also on their polarization state. This latter dependence, and flicker of the output signal caused by polarization fluctuations at the exit from the fiber-optical lightguide, are analyzed here for the case of an input signal wave with linear polarization and a single-mode fiber-optical light-guide. A laser beam passes through a polarizer, crosses a light splitter plate, passes through a phase modulator, then through a circular fiber-optical lightguide, from here through a polarization smoothing vibrator, crosses the light splitter plate in the opposite direction, passes through another polarizer, and is picked up by a photo-receiver. The polarizing characteristics of the lightguide are evaluated in terms of coefficients of the corresponding Jones matrix for a uniformly anisotropic and birefringent fiber. The results reveal that the smoothing vibrator produces a much larger number of polarization states during the averaging time period than the number of polarization states produced by fluctuation. The average magnitude of the interferometer output signal is, therefore, determined mainly by the effectiveness of the vibrator. This conclusion has been confirmed experimentally during recording of the Sagnac-effect phase shift.

Figures 2; references 4: 1 Russian, 3 Western.

[116-2415]

## BROADCASTING/CONSUMER ELECTRONICS

UDC 621.385.832.564.4

### NEW HIGHLY SENSITIVE VIDICON BASED ON CADMIUM SELENIDE

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 82 pp 50-51

[Article by Yu. V. Savel'yev]

[Text] Vidicon L1469, the basic features of which are described below, has a higher sensitivity while retaining a broad dynamic range. Values of dark currents are lower in this vidicon (to units and tens of nanoamperes), as well as signal field nonuniformity and the dark background of the target.

#### Design Features and Basic Parameters

Vidicon L1469 is fabricated on a vibration-resistant base of the design used for units L1435, L1440 and L1451. Use of a separate grid improves image quality and achieves high signal field uniformity. The ratio of grid potential to anode potential is 5:3. The marked improvement in resolution is achieved with a minimal (up to 20%) increase in deflection currents. This property of the vidicon is particularly convenient at low illuminations (less than 0.25 lx).

The improved design-engineering scheme for assembly and processing of sub-assemblies and the device made it possible to improve considerably the parameters of the vidicon projector. For example, total beam current at zero modulator voltage is 10-20  $\mu$ A.

Exact alignment of first anode and modulator apertures is achieved in the L1469 projector; an aperture diaphragm with an aperture made by laser beam is used [1]. These features markedly improved the light-engineering parameters of the device; specifically, the projector signal current was increased from 1  $\mu$ A in previous projector analogs to 1.5-2 in L1469.

The primary component of the target in vidicon L1469 is a highly sensitive cadmium selenide layer, which is applied in a special vacuum unit to a glass disk with a transparent conductive base of indium oxide. A porous layer of antimony trisulfide with a selenium additive is then applied to cadmium selenide in a gaseous nitrogen environment, cooled externally with liquid nitrogen through a metal cover. This layer is necessary for forming the p-n transition and preventing the highly sensitive layer from being burned by the commutating electron beam.

Optimal thickness is selected experimentally for the second layer of the coated surface of the photoconductive target to prevent the possible appearance of extensive dark currents in the network of the signal plate. The dimensions of photoconductive layers during coat application are determined by special mandrels and temperature, time and vacuum conditions.

Vidicon parameters are controlled with use of standard TV scanning and a type A source (illumination for a target area of  $12.7 \times 9.5$  mm is 0.25 lx). In this case, the signal current is 0.1  $\mu$ A, and the dark current depends on signal plate voltage and comprises 3-15 nA. Image field resolution is not less than 600 lines; the residual signal does not exceed 40% 40 ms after light is turned on and depends on the extent of target illumination. Signal nonuniformity in the raster is not more than 15%, and percentage of modulation at the 400 line mark is not less than 35%. At an illumination of 100 lx, the signal current for vidicon L1469 is also not less than 0.1  $\mu$ A, and resolution is 600 lines.

The vidicon is characterized by a rather broad range for signal plate operating voltages: 20-30 V (Fig. 1); in this case, the rather high quality of the image is retained at different signal current values over the entire range from the bottom boundary when a negative image appears to the top when a structural background appears. The vidicon retains its operability in the temperature range of  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

At maximum sensitivity, the light characteristic of the vidicon is almost linear; signal electrode voltage, necessary for sensing the signal, remains basically unchanged in this case (see Fig. 1). Signal electrode voltage must be decreased slightly owing to a leftward shift in the saturation section at low illuminations (below 0.5 lx). The value of dark currents is sharply reduced in

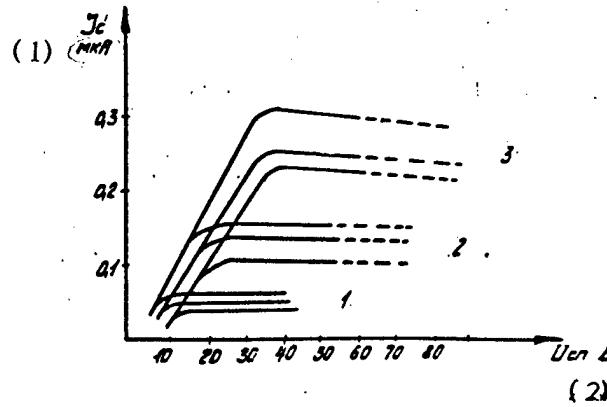


Figure 1. Dependence of current signal on signal plate voltage in maximum sensitivity modes:  
 1)  $E_M = 0.1$  lx; 2)  $E_M = 0.25$  lx; 3)  $E_M = 0.5$  lx.

Key: 1.  $\mu$ A  
 2.  $U_{sp}$  V

this mode and comprises units of nanoamperes. Modulation percentage in the linear section at the 400 line mark is 35-45%. Sensitivity at low illuminations (at dusk) approaches the sensitivity of the eye [4] and increases owing to a shift in the peak of the spectral characteristic into the red region.

The spectral characteristic of L1469 is presented in Fig. 2. It is similar to the characteristic of vidicon L1459 [3]. The use of quartz glass for input windows of the vidicon permits the expansion of the spectral region of sensitivity to 300 nm.

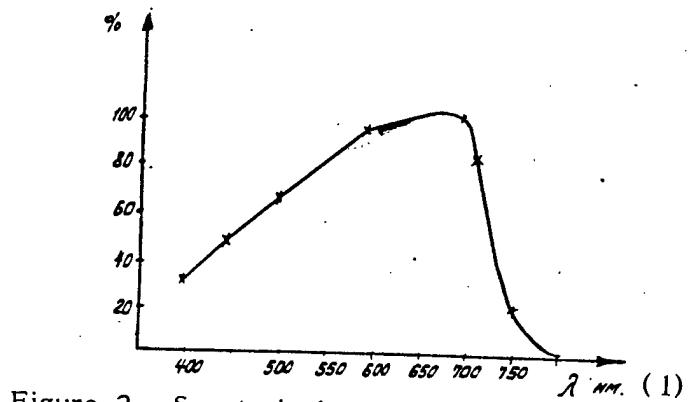


Figure 2. Spectral characteristic of vidicon L1469

Key: 1. nm

Light characteristics of vidicon L1469 are presented in Fig. 3. Voltage requires almost no adjustment at target illuminations  $E = 1-100$  lx, since the value of the signal current depends rather minimally on  $U_{sp}$  in this region. For example, at  $E = 3$  lx, changing  $U_{sp}$  from 15 V to 18 V changes the current from  $0.26 \mu\text{A}$  to  $0.37 \mu\text{A}$ . Signal plate voltage should be regulated at high target illuminations.

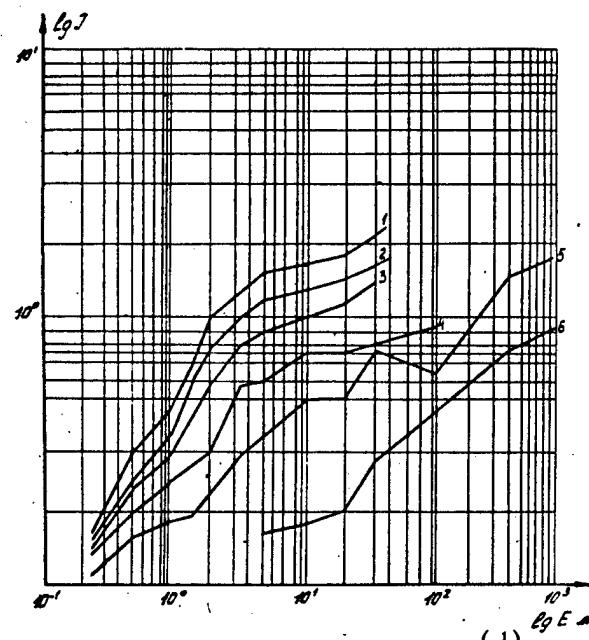


Figure 3. Light characteristics of LI469:  
 1)  $U_{sp} = 30$  V; 2)  $U_{sp} = 25$  V;  
 3)  $U_{sp} = 20$  V; 4)  $U_{sp} = 15$  V;  
 5)  $U_{sp} = 10$  V; 6)  $U_{sp} = 5$  V

Key: 1.  $\log E$   $\log I_x$

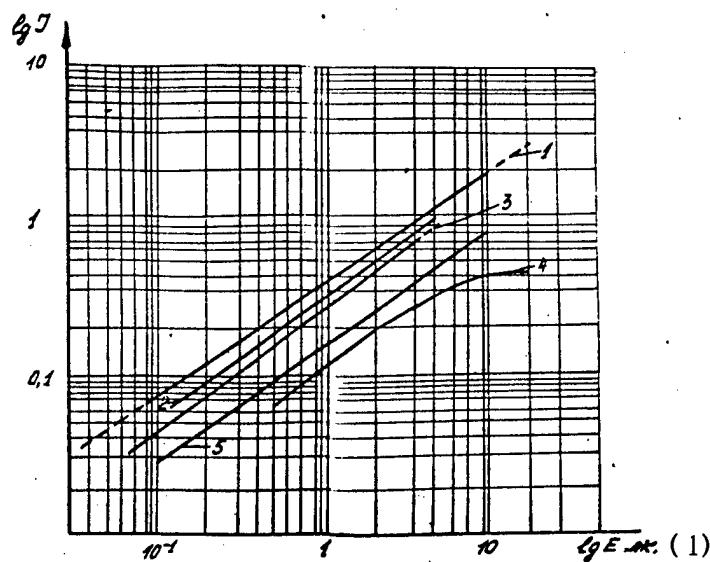


Fig. 4. Light characteristics:  
 1) LI469; 2) LI451; 3) analog of E5063 "Toshiba";  
 4) stibnite vidicon with higher sensitivity;  
 5) LI459.

Key:  $\log E$   $\log I_x$

Vidicon L1469 is capable of operating over a broad range of variations in illumination, 0.1-100 lx. It is evident from the respective light characteristics (Fig. 4) that the new vidicon exhibits high sensitivity over the entire illumination working range. The vidicon is similar in these parameters to highly sensitive cadmicons and has better light-engineering characteristics than camera tubes with a stibnite target. The vidicon is resistant to brief high-intensity flashes (up to  $10^5$  lx), for example, caused by direct entry of rays of sunlight.

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CSO: 1860/107

UDC 519.9

NOISELESS DUEL OF TWO MACHINE-GUNNERS WITH STEPWISE ACCURACY FUNCTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian  
No 4, Jul-Aug 82 (manuscript received 4 May 81, after revision 18 Mar 82)  
pp 190-194

POSITESL'SKAYA, L. N., Moscow

[Abstract] A duel is defined as an antagonistic game in which the players have two kinds of available finite resources which are used in a definite time interval to score a hit against the opponent. The probability of scoring a hit is called the accuracy function of the players. If the  $j$ -th player scores a hit against his opponent, he wins an amount  $A_j \geq 0$  ( $A_1 + A_2 > 0$ ) and play ceases. In the case of a simultaneous hit, the win of the first player is  $A_1 - A_2$ . If both players are alive at the end of the set game time, there is a score of zero. The payment function of the duel is the mathematical expectation of the score of the first player. The duel may be noisy or noiseless depending on the availability or inavailability of information on the opponent's behavior. If the player can use available resources only in unit batches, he is called a sniper. A player that can divide up the available resource in an arbitrary way is called a machine-gunner. In this paper, the author considers a noiseless duel of two machine-gunners with stepwise accuracy functions. She proves the existence of a value in pure strategies. The solution of the game is reduced to solution of a problem of maximizing the function with linear constraints for which necessary and sufficient conditions of the extremum are given. References 8: 5 Russian, 2 Western (in translation).

[60-6610]

UDC 537.87:519.2

STATISTICAL ANALYSIS OF MULTIBEAM FIELD IN URBAN ENVIRONMENT

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 22 Jun 81) pp 2385-2391

KULIKOV, A. N., PONOMAREV, G. A. and SKOVRONSKIY, A. Yu.

[Abstract] Maintenance of stable radio and television reception in a large city depends primarily on the statistical characteristics of radio waves in such an environment. Here the propagation process is described in terms of probability of direct visibility depending on the number and the height of buildings. The zone function characterizing the city geometry is equal to unity when the projection of a radiating point onto the reference plane falls inside a building or on the wall and is equal to zero when it falls outside. The statistics of wave arrival angles and times at a reception point are calculated on the basis of single specular reflections in the approximation of geometrical optics. Assuming a Poisson distribution of the number of buildings per unit area yields a Poisson distribution of the number of waves arriving at a given reception point. The height of buildings is assumed to have an arbitrary distribution, the same in each city zone and thus not depending on the shape of their projections on the reference plane. Multiple reflections and diffuse reflection, also diffraction, appreciably alter the reception pattern and should be taken into consideration in planning a broadcasting system in the decimeter wave band for a city. Figures 4; references 6: 3 Russian, 3 Western (in translation).

[117-2415]

UDC 621.375.4.029.4

SELECTION OF OPERATING MODES FOR AMPLIFIERS WITH COMPOUND DYNAMIC CHARACTERISTIC

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 82 pp 27-28

BESSCHETNOVA, L. V., Northwestern Polytechnic Correspondence Institute

[Abstract] Amplifiers with compound dynamic characteristic are considered for use in portable cinema sound equipment, for which conventional class B amplifiers with a mean-statistical efficiency of 15-20% are inadequate. The problem of adapting such an amplifier for this application is the proper selection of triggering thresholds for each of its stages so as to ensure maximum mean-statistical efficiency and the establishment of acceptable limits of supply voltage fluctuation in order to minimize the loss of technical energy efficiency. Here available performance data on the dependence of mean-statistical efficiency on a triggering threshold are reviewed for the second stage of a two-stage USDKh-2 amplifier and the third stage of a three-stage USDKh-3 amplifier. The optimum triggering thresholds are established and isoefficiency curves are drawn in the threshold field. Figures 2; tables 1; references: 4 Russian.

[106-2415]

UDC 621.391

## QUANTIZATION OF SIGNALS SUBMERGED IN BACKGROUND INTERFERENCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 8 Dec 80) pp 2172-2178

KNYSHEV, I. P.

[Abstract] A digital signal produced by an analog-to-digital converter is regarded as the sum of an analog signal and a quantization noise, the latter being a pseudo-random quantity in the deterministic case and a random quantity in the quasi-deterministic case. The characteristics of such a digital signal are determined here in the case of quantization in the presence of background interference or arbitrary intensity. The analog-to-digital converter is characterized by the number and the spacing of comparison levels  $k = 2^n - 2$  (even) or  $k = 2^n - 1$  (odd), with  $n$  bits in the signal reading. Processing of interference by the converter is characterized by the probability distribution of interference at the output, its mean and dispersion. In the case of a deterministic input signal, specifically, the correlation function for quantization noise is found to depend on the correlation function for interference. On this basis, and with the aid of Kotel'nikov's theorem for uncorrelated signal readings, are determined not only the instantaneous statistics (distribution, mean, dispersion) of the output signal but also the converter performance requirements (time quantization interval, amplitude quantization interval, dynamic range), the limiting effect, and the converter design requirements. Particularly important is the case of a weak signal. Figures 5; references 7: 6 Russian, 1 Western (in translation).  
[116-2415]

UDC 681.84.087.7+778.534.46

## PROBLEMS AND TRENDS IN STEREOPHONY

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 82 pp 3-11

KOVALGIN, Yu. A., Leningrad Electrotechnical Institute of Communications imeni M. A. Bonch-Bruyevich

[Abstract] The feasibility of stereophonic sound transmission and reception was, for the first time in the Soviet Union, demonstrated by professor I. Ye. Goron and his team. Subsequent developments in the nineteen sixties represent a huge step forward in cinematography, broadcasting, and sound amplification. The main deficiency of conventional binaural sound reproduction is the impossibility of fully recreating the acoustics of the music hall, the main problem being to ensure a sufficiently large region of the stereophonic effect (high-fidelity localization of virtual sound sources). It must be possible to control the perception level with necessary adjustments to the sound coloration pattern and to produce special sound effects in the room

around the receiver set. Various systems have been developed in the Soviet Union and abroad to meet these objectives. Most prominent among them are "stereoambiophonic", "delta-stereophonic", "matrix quadrophonic (SQ or QS)" and "discrete quadrophonic" systems. Although the region of high-fidelity localization of virtual sound sources is larger in discrete quadrophonic systems, addition of gain control logic to the decoder in matrix quadrophonic systems has made the latter approach the same quality level. Another system is the AVS with a set of four balanced loud-speakers and a panoramic encoder. This system, developed at the Leningrad Electro-technical Institute of Communications and successfully tested at the "Melodiya" All-Union Phonographic Recording Studie, is now put on the market. Further research is done on development of a biophonic system, to overcome the effect of reverberations. In this area the results are still modest, stability of the stereophonic effect and compatibility with conventional binaural stereophony presenting problems yet to be resolved. Figures 8; references 26: 13 Russian, 13 Western (4 in translation).

[106-2415]

UDC 778.5:621.397.13

#### TELEVISION FACILITY COMPLEX FOR ACTOR SCREEN TESTS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 82 pp 12-17

KHAZANOV, G. I., "Mosfil'm" Motion Picture Studio

[Abstract] A television facility complex has been laid out and installed at the "Mosfil'm" motion picture studio, adequate for handling the high volume of over 400 screen tests with up to 1500 actors annually. Most of the floor area, 10x16 m<sup>2</sup>, is occupied by the pavillon with interior decoration for "kitchen", "study room", "living room", and "cottage" setups. The rest of the floor area, 5x16 m<sup>2</sup>, is assigned to a ventilation chamber, an equipment stockroom, an actors' make-up room, and an actors' lounge. The television equipment includes a TPU-22 thyristor-type 110 kW power supply built at the Tallinn experimental plant for cinema equipment, a lighting control panel, and a video-audio complex. Auxiliary equipment includes postz for mounting and cranes for moving cameras and lights of other equipment. Facilities are also provided for video recording with simultaneous sound tracking, inspeciton and reproduction of tapes, editing, viewing by arts council and viewing management. Screen testing with the use of television facilities has proved itself as an effective method. Techniques and quality standards have been developed on the basis of experience already available. Figures 10.

[106-2415]

COMMUNICATIONS

UDC 621.37:519

APPROXIMATION OF FUNCTIONS DESCRIBING DISTRIBUTIONS OF PHASE AND OF ITS COSINE  
IN MIXTURE OF HARMONIC SIGNAL AND NOISE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 25 Nov 80, after correction 14 Dec 81) pp 1779-1783

ATAYANTS, B. A. and KARPOV, A. F.

[Abstract] An additive mixture of harmonic signal and stationary normal narrow-band noise is considered. The analytical expressions for the one-dimensional probability distributions of its phase and of the cosine of its phase are rather unwieldy for practical purposes, which makes it necessary to seek approximations. Simple asymptotic models are known for the extreme cases of very weak and very strong signals. Here approximations are sought which describe these probability density distributions in the range of signal levels comparable with the rms noise level. They are selected according to the Pearson method of moments and found as a family of empirical curves. While the standard approximation is more accurate than the Pearson type-II distribution (symmetric beta-distribution) for weak signals and the Pearson type-VII distribution (asymmetric beta-distribution) is more accurate than the corresponding standard approximation for strong signals, it is possible to make the Pearson type-I distribution (generalized beta-distribution) most accurate of all at any signal-to-noise ratio. Figures 5; references 4: 3 Russian, 1 Western (in translation).

[103-2415]

UDC 621.391.2

SYNTHESIS OF ADAPTIVE LEVEL ANALYZER OF NONSTATIONARY RADIO INTERFERENCE

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 19 May 80)  
pp 67-69

KOVESHNIKOV, V. G. and SHAROV, A. N.

[Abstract] A level analyzer of interference in a radio communication system is synthesized for a given frequency band in accordance with the maximum-likelihood

criterion. The difference equation describing the dynamics of interference level at each frequency represents the state vector at each discrete instant of time as the sum of the state matrix and the excitation matrix. The aim is to maximize during measurements the conditional probability of the input process relative to the a priori given parameters of the measurement model. It is assumed that the state vector represents a correlational Markov sequence of normally distributed random quantities and that the probability density of the input process has a Gaussian distribution, in which case only its mathematical expectation and dispersion need to be calculated for its complete determination. Subsequently, maximizing this probability density requires an extremely close approximation of the synthesized model to the parameters of the real process, which is done much more expediently by minimizing its negative logarithm. The resulting analyzer includes a commutator, a switch, a selector of the minimum penalty-function value and thus also of the corresponding weight factor, a memory, a logarithm taking device, and a set of penalty-function computing devices. Such an analyzer was simulated on a digital computer according to an algorithm using a posteri ori data on the correlation of input interference levels. Following the identification process, the estimate soon becomes unbiased. Figures 4; references 5: 3 Russian, 2 Western (in translation). [101-2415]

UDC 621.391.83:621.396.96:621.391.26

#### ESTIMATING PARAMETERS OF PERTURBATIONS ALONG LONG-RANGE RADIO COMMUNICATION ROUTES

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 11 Feb 82)  
pp 70-73

GERASIMOV, Yu. S., GORDEYEV, V. A. and KRISTAL', V. S.

[Abstract] Perturbations along long-range radio communication routes (fluctuations of the ionosphere, meteor showers, Faraday effect) must be taken into account in the design and optimization of self-adapting long-range radio communication systems. The parameters of these perturbations, all with attendant frequency dispersion and time delay, are usually estimated with the aid of pulse test signals often revealing no deterministic relation between results of measurements and a priori exactly known data. Here this indeterminacy is explained by describing the input signal in the form of a Fredholm convolution integral of the first kind, its evaluation upon conversion to a series being generally an inverse and incorrect problem where discretization of the argument leads to a system of ill-conditioned linear algebraic equations with an unstable solution. A method is proposed for quantitative estimation of indeterminacy, using a factor  $\text{cond}(A) = \|A\| \|A^{-1}\|$  ( $A_{ij}$ -matrix of coefficients in the series) as measure of attainable estimation accuracy and thus also as criterion of measurement efficiency. Its minimum value being  $\text{cond}(A)_{\min} = 1$ , it yields the real unremovable error when calculated according to an algorithm of mathematical simulation with use of a priori data on a limited class of

sought solutions. Parameters and form of the test signal must then be selected on the basis of this criterion to meet the measurement resolution requirements. Figures 3; references 6: 5 Russian, 1 Western (in translation). [101-2415]

#### RECEIVER FOR SPORTS-TYPE RADIO DIRECTION FINDING (PART 1)

Moscow RADIO in Russian No 6, Jun 82 pp 21-22

KETNERS, V., master radio instructor, DOSAAF (All-Union Order of the Red Banner Voluntary Society for Assistance to USSR Army, Air Force and Navy

[Abstract] A receiver for sports-type radio direction finding has been developed which is both versatile and conveniently small. Its basic operating mode is "fox hunt", its operating frequency band is 3.5-3.65 MHz. Its major components are a loop antenna and a rod antenna, the latter added for obtaining a cardioidal radiation pattern, an amplitude detector, a d.c. amplifier, two threshold devices, a controlled h-f amplifier, a 4-4.165 MHz heterodyne oscillator, a mixer, an i-f amplifier, a 500 kHz quartz oscillator, a balancing mixer, an l-f amplifier, a digital frequency scale and indicator lamps. Its special features include automatic "fox" tracking with "fox" frequency memory, automatic frequency control, sensitivity regulation, a built-in electronic watch and a built-in loudspeaker. The receiver operates from a 7D-0.1 battery, drawing a maximum of 50 mA. Continuation of article is to follow. Figures 2.

[118-2415]

UDC 621.396.626

#### DYNAMIC RANGE OF MULTIFREQUENCY DEMODULATORS

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 8 Dec 81)  
pp 45-47

GIRSHOV, V. S.

[Abstract] An expression is derived for the dynamic range which a demodulator must have in order to ensure operation of the radio receiver at full capability without automatic gain control, the latter being disconnected so as to eliminate nonlinear distortions caused by shifting of the amplifier operating point. The derivation is based on averaging the output signal power over fast fadeouts and on invariance of the input signal power during weakly correlated fluctuations of subcarrier amplitudes. Subsequently an expression is derived for the loss of output signal power as a result of a smaller dynamic range of a demodulator designed for operation with, but operating without automatic gain control. Finally an expression is derived for the reliability of a receiver, in terms of the probability that the power level will fall within the given range. Figures 1; tables 1; references: 8 Russian.  
[101-2415]

DESIGN OF MULTISTAGE DETECTOR OF BINARY-WISE QUANTIZED PULSE SIGNALS FOR  
MINIMUM DETECTION TIME

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 9 Dec 81)  
pp 62-66

SVETLICHNAYA, A. A.

[Abstract] A multistage detector of binary-wise quantized pulse signals is considered and the effectiveness of minimizing the detection time is analyzed. The detection process is assumed to involve independent testing of hypotheses in each stage. Only when the hypothesis of a signal present in any one stage is accepted does the detection process continue into the next stage. A signal detected is one found to be present in all stages, the decision about a signal being made in the last stage for each distance resolution element. The conditions of detection are assumed to be the same throughout the entire distance range and the signal-to-noise ratio is assumed to remain constant throughout the entire detection procedure, a useful signal existing only in one resolution element while only noise exists in all others. On the basis of this model are calculated the false-alarm probability and then the correct-detection probability. The detection time is determined by the data gathering time and, in the case of a constant probing period, is proportional to the number of accumulated pulse signals. Constraints on the detection characteristics are now established which will ensure minimization of the detection time. Calculations for a two-stage detection procedure with false-alarm probability  $F=10^{-6}$  and correct-detection probability  $D=0.5$  indicate that a number of resolution elements within  $10^2 - 10^3$  is sufficient, inasmuch as a number larger than that will not further decrease the detection time cost effectively. Figures 3; references: 5 Russian.

[101-2415]

DIGITAL INDICATOR OF CARRIER FREQUENCIES

Moscow VESTNIK SVYAZI in Russian No 12, Dec 82 pp 26-27

GORDEYEV, I. A., senior technician, SUR-1

[Abstract] A completely automatic digital frequency indicator has been developed at the SUR-1 enterprises for reading carrier frequencies and checking their stability at radio transmitter stations. It is built with series K155 integrated microcircuits. It does not have its own high-stability reference oscillator but can be used with any external 100 kHz frequency standard as reference. The device includes an R-250 medium-wave receiver as well as long-wave one and a short-wave one, two heterodyne oscillators with pulse shapers, a commutator, a single-stage KT325B-transistor amplifier, and a reversible binary-decimal counter for adding the heterodyne frequencies and subtracting

the intermediate frequency. Five pulse of respectively 2 s, 1 s, 1 s, 10  $\mu$ s, and 0.999 s duration are generated for the frequency count and indication process. The total error of frequency readings is 1.73 Hz and the maximum error caused by inaccurate pulse formation is  $\pm 3$  Hz. Figures 1.

[111-2415]

#### DEVICE FOR CHECKING TAPE PUNCHER SET IN 'ONEGA III-ZE' COMPLEX

Moscow VESTNIKA SVYAZI in Russian No 12, Dec 82 p 28

IVANOV, V. L., electrical technician, workshop No 3, Production-Engineering Administration of Leningrad Urban Postal Service

[Abstract] The author has invented a device for checking and regulating tape puncher sets in the "Onega III-ZE" electronic postal service system, at workshops as well as at branch offices. Reliable checking requires at least 1500 operations, which this device performs automatically and without subjective errors. It operates in the "payment-receipt" mode (27 and 13 digits respectively), also in the "Christmas tree" mode for regulation of the tape punching process with fault detection and elimination. Major faults thus prevented are omission of hole, closure of electromagnet, change of perforation step. The set weighs 0.3 kg, its construction is simple and its performance is reliable. Figures 2.

[111-2415]

CIRCUITS & SYSTEMS

UDC 62-50,519.2

ITERATIVE METHODS OF SYNTHESIZING ADAPTIVE FILTERS WITH FINITE MEMORY

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian  
No 4, Jul-Aug 82 (manuscript received 25 Mar 82) pp 3-10

SHIL'MAN, S. V., Gorkiy

[Abstract] Adaptive filters with finite memory are synthesized for isolating a useful random signal against a background of additive interference. If the processes are steady-state in the broad sense, and if their mathematical expectations, correlation and mutual correlation functions are known, an optimum linear filter can be found. The parameters of this filter are determined with respect to the criterion of the minimum mean square error of estimation. The author solves the problem of synthesizing linear filters with finite memory under conditions of incomplete information. It is assumed that the useful signal and noise are mutually independent, that the correlation function of the interference is known, and that the correlation function of the useful signal is not given. The useful signal may have a deterministic polynomial component, and observations need not be steady. The solution involves iterative algorithms of stochastic optimization of Quasi-Newtonian and gradient type. An investigation is made of convergence of adaptive filters to optimum with probability of 1. References 11: 8 Russian, 3 Western.  
[60-6610]

UDC 621.317.757

COMPUTER-AIDED DESIGN CALCULATION OF DYNAMIC CHARACTERISTICS OF SELECTIVE DEVICES

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian Vol 4, No 6, Nov-Dec 82  
(manuscript received 29 Aug 81, after completion 9 Dec 81) pp 55-58

SITNIK, A. G. and MARTYNENKO, V. Ye.

[Abstract] A mathematical model is constructed for calculating the dynamic characteristics of an N-sections filter (N-stages tuned amplifier). The model covers arbitrary initial conditions as well as variable signal frequency and

amplitude, and thus also a generally variable bandwidth. Each filter section is assumed to have unity gain, infinite input impedance and zero output impedance. The differential equations of this model are put in a form suitable for numerical methods such as the Runge-Kutta on a computer. As an example, calculations are shown for a voltage input signal  $E = E(t)e^{j\int \omega dt}$  to a filter

circuit describable by the equation  $\frac{d^2q(t)}{dt^2} + \frac{2\delta dq(t)}{dt} + \frac{\omega^2}{r}q(t) = \frac{E(t)}{L}$

(q- charge,  $\delta = \frac{R}{2L}$ ,  $\omega^2 = \frac{1}{LC}$ , R(t)- variable resistance L- constant

inductance, C- constant capacitance). The problem is solved by the method of slowly varying amplitudes. Numerical dynamic characteristics have been obtained on a YeS10-33 Unified System computer with an average of 3.5 min per curve for initial levels of -80 dB and -60 dB, respectively, assuming either a linearly varying rate or a constant rate of change of input signal frequency. Figures 1; tables 1; references 5: 3 Russian, 2 Western.  
[119-2415]

UDC 621.372.8.049.75

#### USE OF ASYMMETRIC SLOT LINE IN MICROWAVE MICROCIRCUITS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 7 Apr 81) pp 2110-2116

GVOZDEV, V. I.

[Abstract] Use of an asymmetric slot line facilitates microminiaturization of integrated microwave circuits where the design requires combining different transmission lines through appropriate transitions. On the basis of approximate empirical relations for the effective dielectric permittivity and the characteristic impedance of asymmetric slot lines (dielectric constant of material 2.5-38, thickness of strip 0.5-2 mm, operating frequency 3-10 GHz) are shown designs and performance characteristics (coefficients of scattering matrix) of several microwave devices: ring-type half-wave bridge, loop-type directional coupler, ring-type cophasal and antiphasal balanced power dividers, and multi-channel power divider. The author thanks professor Ye. I. Nefedov for his interest. Figures 7; references 16: 11 Russian, 5 Western.  
[116-2415]

## SYNTHESIS OF THREE-STAGE THREE-OCTAVE FILTER

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
 (manuscript received 29 Jun 81) pp 99-105

DEKHTYARENKO, P. I., TURCHANOVSKAYA, L. N. and TURCHANOVSKIY, A. N., Institute of Electrodynamics, UkrSSR Academy of Sciences, Kiev

[Abstract] A three-octave filter is synthesized by connecting three selective detectors in series, each having an amplitude-frequency characteristic  $y =$

$$1/\sqrt{1+Q^2\left(\frac{f}{f_r}\right)^2} \quad (Q = 2\pi fL/R, f_r - \text{resonance frequency of individual stage, } f_0 - \text{center frequency of complete filter})$$

stage,  $f_0$  - center frequency of complete filter). The four unknown parameters  $Q_1 = Q_3$ ,  $Q_2$ ,  $f_0/f_{r1} = f_{r3}/f_0 > 1$  ( $f_0 = f_{r2}$ ), and transmission coefficient  $y$  at frequencies  $f_0$ ,  $1.0595(0.9439)f_0$ ,  $1.1225(0.8909)f_0$ , and  $1.2599(0.7937)f_0$  are calculated from the corresponding system of four independent equations. The filter performance has been simulated on an SM-3 analog computer. The results, including deviations from GOST 17168/69-71 specifications, are compared with those obtained by this method for an analogous Brüel & Kjaer filter. The authors thank M. I. Solomakha, chief engineer at the Institute of Electrodynamics (UkrSSR Academy of Sciences) for performing the calculations of an SM-3 computer. Figures 4; tables 1; references: 3 Russian, 1 Western in translation.

[105-2415]

## INCREASING OUTPUT POWER OF WIDEBAND MICROWAVE OSCILLATOR TRANSISTORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
 (manuscript received 21 Dec 81) pp 2408-2414

DIKOVSKIY, V. I. and YEVSTIGNEYEV, A. S.

[Abstract] Factors limiting the effectiveness of compounding the output power of wideband microwave oscillators by paralleling several transistors are analyzed and ways to increase this effectiveness are proposed. The main limiting cause is mismatch of components at frequencies other than a certain target frequency, especially at higher but also at much lower frequencies. Other causes include positive feedback and large size of the transistor bank structures. An analysis of transistor performance in a parallel array reveals interaction between components which can result in phase shifts between individual outputs and parasitic standing voltage waves, unless the resonance frequency is

at least twice the operating frequency and the length of a transistor bank much smaller than half the wavelength. The remedy therefore is to decrease the collector inductance and capacitance, to achieve internal matching, completely compensate the collector capacitance by connecting an LC  $\pi$ -circuit and, still better, also a plain LC circuit across it. Another effective measure is splitting the collector junction into isolated strips, at least two, matching each at the common output and noninductively connecting the plates of their matching-circuit capacitors so as to suppress mutually induced oscillations by the loss resistance of the connecting circuit. These methods have been tried experimentally, with success, on 0.7-1.4 GHz 110-75 W transistors with MOS capacitors in both matching sections. Figures 2; references: 2 Western.  
[117-2415]

UDC 621.396.62

#### INFRADYNE RECEPTION

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 11 Jan 82)  
pp 3-13

BOGDANOVICH, B. M., VORONOV, A. I., ZABEN'KOV, I. I. and POZNYAK, S. S.

[Abstract] Developments in infradyne receivers are reviewed which have made feasible the use of wideband preselectors. With the probability of signal suppression as a measure of vulnerability to interference, an analysis of their performance characteristics serves as guide to reduction of this probability in various frequency bands of possible interest. There follows design optimization of the receiver channel, with the dynamic range as criterion, and inclusion of automatic control of interference gain by any of several available methods (tracking the input perturbation or the channel response to it, wideband or selective, at one channel section with attenuator usually at the input or at several channel sections with appropriately variable gain, analog or digital, individual or centralized regulation of components). The basic general algorithm of this control is formalized, including channel adaptation with respect to interference threshold. The structure of modern infradyne receivers with wideband preselectors for long, medium, or short waves consists essentially of amplifiers and frequency converters with auxiliary means to ensure high degree of linearity in the high-frequency stage and a high degree of stability in the heterodyne stage. The design of components has been sufficiently diversified to suit a variety of application ranging from music halls to radio broadcast reception via the "Orbita" system. Figures 9; references 31: 24 Russian, 7 Western.  
[101-2415]

UDC 621.396.96;621.391.26

ANALYSIS OF DIGITAL ADAPTIVE BAND-ELIMINATION FILTERS

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 6 Oct 81)  
pp 53-56

POPOV, D. I.

[Abstract] The performance of digital adaptive band-elimination filters is analyzed in terms of the dependence of their efficiency on the size of the learning sample, the digit capacity of the analog-to-digital converter, and the arithmetic unit. Errors caused by finite digit capacity are taken into account as uncorrelated interperiod discrete quantization noise. The envelope of the correlation function is assumed to be known. The necessary relations are established utilizing the asymptotic properties of maximum-likelihood estimators. They can be used for design purposes. Figures 3; references: 6 Russian.

[101-2415]

UDC 681.7.014.3

ALGORITHM FOR IDENTIFICATION OF MICROCIRCUIT TOPOLOGY ELEMENTS: CONTROL OF QUALITY OF THEIR ACCOMPLISHMENT

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct (manuscript received 5 Aug 81) pp 452-455

BRYUKHOVETSKIY, A. A., Seastopol Institute of Instrument Building

[Abstract] This brief communication proposes a method for identification of the elements of the topology of microcircuits, which is realized on the basis of successive processing of images and does not require large computing resources. An algorithm is developed for a minicomputer. The following items are discussed: 1) Formulation of problem; 2) Methods of identification; and 3) Description of algorithm. Figures 2; references 6: 2 Russian, 4 Western (1 in translation).

[24-6415]

COMPONENTS, HYBRIDS & MANUFACTURING TECHNOLOGY

UDC 620.179.14

INFLUENCE OF LATERAL GROOVE DIMENSIONS ON MAGNITUDE OF WORKPIECE-ORIENTING ELECTRODYNAMIC FORCE

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I TEKHNICHEСKIKH NAUK in Russian No 4, Jul-Aug 82 (manuscript received 29 Jan 82) pp 121-125

KANAYEV, A. S., Robotics Center, Physics Institute, LaSSR Academy of Sciences

[Abstract] Experiments are done in order to determine the effect that relative dimensions of a groove in the side of a nonmagnetic current-conducting part have on the magnitude of the force set up by an electromagnet used to orient the piece for purposes of checking and sorting. Measurements were done on an electromagnetic balance with various configurations of the external alternating magnetic field. Increasing the width or depth of the feature to be oriented always reduces the force effect. Increasing the working frequency of the electromagnetic field increases the force effect up to a certain point, beyond which the force ceases to increase, and the field energy goes to heating up the workpiece. The relations observed between the size of the feature to be oriented and the force acting on this feature have been put to use in developing industrial sorting devices with productivity of 60-800 parts per minute.

Figures 5; references: 2 Russian.

[58-6610]

UDC 621.049.77:002.54.621.757

MANUAL BREAK-FREE UNILATERAL-TRIM INSULATION WINDER FOR MICROCIRCUIT ASSEMBLY

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 37-38

GREBENNIKOV, V. A., engineer

[Abstract] Two variants of a manual break-free unilateral-trim insulation winder for integrated-microcircuit assembly have been designed built, and certified for use in conventional workshops. Both are mounted in a type-2 frame. Each consists essentially of a crank formed by a steel rod 3 mm in diameter, with a 16.5 mm long disk 8 mm in diameter nested in it on a transverse

pin welded on it at the center. A coil is slipped around this disk and retained on it by a snap ring on the outside end of the disk. In the first variant a spring-loading 18 mm long split sleeve is welded to the crank rod 10 mm below the knee and a cylindrical end clip is inserted into it. In the second variant, an improvement of the first, the crank rod is cut flatly with a 0.3 mm thick and 2 mm wide "whisker" 25 mm below the knee and a flat end clip is banded to it tightly with copper wire. These winders are recommended for insulating copper wire with EVTL or EVTLK material. Figures 4; references 4: 2 Russian, 2 Western (1 in translation).

[109-2415]

COMPUTERS

UDC 62.50:519.24

REGULAR METHOD OF OBTAINING FEATURES FOR IDENTIFYING FLAT OBJECTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian  
No 4, Jul-Aug 82 (manuscript received 10 Jun 81) pp 132-135

KOLISKOR, A. Sh., LASHKO, Ye. B., MODEL', B. I. and SALAMANDRA, B. L.  
Moscow

[Abstract] A major problem is introducing robotic systems with vision is to match the time characteristics of operation of the motor subsystem of a robot with the subsystem for processing visual information. As a rule, because of the complexity of the jobs to be handled, motor acts are accomplished 3-4 times more rapidly than processing of visual information. The authors propose an approach for compiling a rapid algorithm of identification of flat objects for use in sorting, assembling and stacking flat parts presented in any configuration in the working zone of the robot. The problem of getting invariant features for recognition is solved by expanding some function of the outline of the object in a Fourier series, because for any set of distinguishable objects there is always a finite number of terms of such a series that uniquely defines any object of the set. The identification features are the Fourier coefficients and the second differences of adjacent phases, while the phases themselves are used for determining the orientation of the object. The method developed in this paper is intended for use in the software systems for artificial vision of robotic devices. The resultant features are invariant with respect to scale, transposition and orientation of objects. Figures 1; tables 1; references 3: 2 Russian, 1 Western.  
[60-6610]

UDC 621.316.925

PROBLEMS IN CALCULATION OF COMPOUND ASYMMETRIES IN ELECTRIC NETWORKS ON THIRD-GENERATION COMPUTER

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
(manuscript received 4 Jan 82) pp 80-86

KRYLOV, V. A., Institute of Electrodynamics, UkrSSR Academy of Sciences, Kiev

[Abstract] A method has been developed and programmed at the Institute of Electro-dynamics for calculating, on a third-generation computer, compound asymmetries in electric networks such as simultaneous short circuits at various nodes, partial (two- or one-phase) open circuits in various branches, simultaneous open circuits in various branches, etc. The method is a logical extension of that already available for full (three-phase) switching. The algorithm involves setting up circuit matrices with symmetric and asymmetric elements, then performing the appropriate operations until the equivalent-circuit parameters as well as voltages and currents are determined. The composite program V-VI-18, adequate for networks with up to 1000 nodes, is written for M-4030 and YeS (Unified System) computers. References: 5 Russian. [105-2415]

UDC 621.372.832.029.64

HIGH-POWER MICROWAVE BRIDGE-TYPE ADDER

Moscow RADIOTEKHNika I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 19 May 81) pp 2242-2244

ZAYENTSEV, V. V. and MINKIN, M. A.

[Abstract] A multichannel parallel-type microwave power adder in the form of a bridge is described where the  $N$  branches between common point 1 and points  $2, \dots, N+1$  are identical line segments with an electrical length shorter than a quarter-wave, which ensure high efficiency, and with a characteristic impedance equal to that of the channel. The bridge arms on the other side of points  $2, \dots, N+1$  consist of identical quarter-wave line segments, each in series with another line segment shorter than a quarter-wave. The latter are connected to a common point at the other ends and from there through a capacitive load to ground. Ballast resistors grounded at one end tap into the bridge at the junction points between the quarter-wave line segments and these shorter line segments, which increases the power capacity of the device with the size of these ballast resistors appropriately selected. The performance characteristics of the device, namely the decoupling between branches and the voltage standing-wave ratio, have been calculated over the  $(0.8-1.2)f_0$  frequency range for  $N=2-10$  channels with either the ballast resistance equal to the characteristic impedance of the channel or the characteristic impedance of all quarter-wave line segments equal to that of the channel. As the number of channels is increased, both the decoupling and the VSWR increase but over a narrower frequency band. Figures 2; references: 4 Russian.

[116-2415]

STRUCTURAL-CIRCUIT ENGINEERING REALIZATION OF LIC BUNKER MEMORY UNIT

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82  
(manuscript received 23 Jul 81) pp 430-440

VESHNYAKOV, V. I., and KARDASHCHUK, M. D.

[Abstract] Bunker memory units (ZU) consist of storage single stage shift registers. The structural-circuit engineering special features of the latter determine the properties of all the ZU. One of the high-order uses of small capacity bunkers is matching of the ZU to disks and drums with a microprocessor. Bunkers of average capacity are used for bufferization of data in micro-computers. The great interest in the problem of digital processing of signals, and in particular to the practical realization of special processors of BPF type, leads to the necessity to have a large capacity bunker ZU. A bunker ZU operates according to the principle: first recorded word is removed first (first in -- first out). A unique feature of a bunker ZU is the possibility of asynchronous independent operation of its input and output as well as the possibility automatically to multiplex the large mass of stored data. Figure 1 of the text shows: 1) The principles of the structural organization of a bunker ZU; and 2) An IC bunker with exterior lead outs. Figure 2 shows the structural-logical circuit of the controlling register of a bunker ZU. The classifications of bunker ZU are listed in a table. An I<sup>2</sup>L structure can be a convenient element base for realization of a bunker ZU of large capacity. In particular, a ZU with a Schottky diode and a p-channel MOS structure with depleted loads are of service. The most simple bunker ZU of large capacity (2--4 Kbit) is realized as a synchronous IC. As a static ZU, buffers are free from a number of circuit engineering limitations. As an example the unit for registration memory is not loaded on the common busbar. As a result of this, a high rate of switching with moderate power consumption is attained. Such an IC does not transmit weak signals with respect to long consumption lines with a high noise level. The IC of bunker ZU possesses high homogeneity and contains only two basic topological fragments, which in addition to the convenience of designing, contributes to the achievement of higher characteristics. Figures 7; references 22: 19 Russian, 3 Western.  
[24-6415]

UDC 621.382

COMPARISON OF FLIP-FLOP READING AMPLIFIERS FOR STATISTICAL IMMEDIATE ACCESS MEMORY BASED ON KMDP TRANSISTORS

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82 (manuscript received 4 Sep 81) pp 441-446

GERASIMOV, Yu. M., GRIGOR'YEV, N. G. and KARMAZINSKIY, A. N., Moscow Engineer-Physical Institute

[Abstract] The current of a statistical memory element (EP) creates on the discharge busbars, a voltage sufficient for switching on of an inverter. However, such a direct reader of information is connected with considerable delays. These are increased by a growth of the information capacity of the memory (ZU). Consequently, it is necessary to use reading amplifiers (US) in order to increase the speed of response of the ZU. The present paper evaluates the gain in the speed of response given by the use of flip-flop reading amplifiers with regeneration of information at the discharge buses and without regeneration, in comparison with direct reading of information. The following items are examined: 1) Principles of operation of reading amplifiers; 2) Parameters of reading amplifiers; and 3) Analysis of reading. The paper concludes that with respect to effectiveness an amplifier without regeneration of information at the discharge buses, exceeds by 2-3 times the effectiveness of an amplifier with regeneration of information at the discharge buses with an increase of the information capacity. With an increase of the information capacity of the ZU, the effectiveness of use of a reading amplifier without information, regeneration at the discharge buses is increased in comparison with an amplifier with regeneration. Figures 5; references 4: 3 Russian, 1 Western in translation.

[24-6415]

UDC 621.383

MDP-p-n-MEMORY ELEMENT WITH OPTICAL CONTROL

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82 (manuscript received 5 Aug 81) pp 460-463

PLOTNIKOV, A. F., SELEZNEV, V. N. and SAGITOV, R. G.

[Abstract] In recent years much attention has been paid to investigating switches of the type metal--dielectric (with leakage) semiconductor with p-n junction (MDP-p-n). Use of these switches as memory is promising. This is particularly true of optically controlled memory elements. In 1981 the authors of the present brief communication proposed a memory element with optical control based on a MDP-structure with wide band tunnel-thin dielectric. However, it had an insufficiently high speed of response and a fairly strong limitation on the level of background illumination. The authors state that the MOP-p-n-switches investigated in the present communication are free from the

shortcomings indicated. Experimentally, the possibility is shown of the use of MDP-p-n switches as optical memory elements. Optical control by the element is accomplished in all operations of the element: recording, reading and erasure. In comparison with known (e.g., MNOP elements), the advantage of such an element is the high speed of response, and the stability during multiple switchings. The element proposed is promising for use in optical devices of large capacity. The authors thank F. A. Pudonin for preparation of specimens. Figures 3; references 8: 2 Russian, 6 Western.  
[24-6415]

UDC 681.32:519.95

MULTIVALEU TECHNIQUE IN COMPUTER TECHNOLOGY: ACHIEVEMENTS, PRESENT STATUS, OUTLOOK

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian Vol 4, No 6, Nov-Dec 82  
(manuscript received 8 Oct 81) pp 59-64

BOBROV, A. Ye. and RAKOV, M. A.

[Abstract] Compatible development of computer hardware and software, taking into account the continuing trend toward large-scale integration, calls for unconventional solutions of problems such as design and use of multivalue structures, logic, circuitry, and alphabet. Achievements in this direction have been made in three stages: 1) Establishment of a digital and analog electronic computation techniques; 2) Incorporation of semiconductor devices; and 3) Production of multivalue computer elements. The principle of this approach is demonstrated on three variants of an example illustrating r-transformation (rows) only, h-transformation (columns only), and r,h-transformation of a matrix. There are indications that the fourth stage of development in this direction is already in progress, namely experimental verification and establishment of guidelines for further broader applications in general-purpose as well as special-purpose computers. Much work is being done at seminars held at the L'vov Physico-Mechanical Institute, UkrSSR Academy of Sciences. References 7: 6 Russian, 1 Western.  
[119-2415]

MEASURING-COMPUTING COMPLEX K537 WITH MICROPROCESSOR CONTROL

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 29-30

BOGOSLAVSKIY, G. Ye., candidate of technical sciences, ZELENEVSKIY, V. S., candidate of technical sciences, PLOTNIKOV, V. V., candidate of technical sciences, ZARUBIN, L. I., candidate of physico-mathematical sciences, KOKHAN, V. S., engineer, SAFONOV, V. R., engineer, and SINEL'NIKOV, A. V., engineer

[Abstract] The measuring-computing complex K537, based on K580IK80 microprocessor, constitutes an intermediate version between conventional low-cost data recorders and high-cost complexes on a minicomputer base. It was developed by the Institute of Semiconductors at the UkrSSR Academy of Sciences jointly with the Kiev "Tochelektronpribor" (Precision Electrical Instruments) Industrial Association. Its structure is built on a main system busbar through which data are transferred and command signals as well as control signals are transmitted to and from the central processor. The latter is thus interfaced with an analog-to-digital converter, and external commutator and an internal one, a control panel, a set of current sources, a "Consul" electric typewriter, a PL-80 puncher, a direct-access memory, a read-only memory, and an SM-3 mini-computer. Measurements can be made either automatically in a preset sequence or cyclically with a given number of repeat runs and subsequent waiting for new instructions. The accuracy of measurements, especially with weak signals, is enhanced by subtraction of multiplicative and additive error components. The complex is designed for measuring and computing direct voltages in the 0-10, 0-1, 0-0.1 V ranges, direct currents in the 0-5-10<sup>-3</sup> A range, electrical resistances in the 10-10<sup>5</sup>, 10-10<sup>4</sup>, 10-10<sup>3</sup>, 10-10<sup>2</sup> ohms ranges, and temperatures (with TPK probes) in the 4-20, 20-100, 100-300 K ranges. Figures 2; tables 1; references ] Russian.

[109-2415]

DATA PROTECTION IN COMPUTER SYSTEMS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 p 47

YAKUBOVICH, M. M., doctor of technical sciences, and KOZLOV, N. N., candidate of technical sciences

[Abstract] This is a review of the brochure "Data Protection in Computer Systems" by B. M. Rudzitskiy (Moscow, Izd-vo Znaniye, 1982, 64 pp). The material in this brochure covers dangers encountered in each stage of data processing and the principles of protection, all illustrated with practical examples. The protection system is treated as a rational structure of hardware and software. Particularly extensive is the chapter on "Protection of Input and Output", where much attention is paid to identification of protective devices and programs. In the chapter on "Protection of Processing" the author

has defined the main trends in such areas as protection of users' terminals and access, fail-proof data conversion, and organization of multiaccess operation. Most difficult is the material on protection of compatible data processing. The last chapter on "Protection of Transmission and Storage" deals with the two interrelated problems. All the material in this brochure is well presented. Examples have been well selected, especially those illustrating the peculiarities of data encoding and decoding. Information is also given on foreign trends and achievements in data protection. The major deficiency of this brochure is lack of a special chapter on data protection in statistical data bases.

[109-2415]

#### 'OMEGA-2M' SPECIAL-PURPOSE PROCESSOR

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian Vol 4, No 6, Nov-Dec 82 p 103

BLEYER, Ya. F., GRUNIDSHTEYN, A. Ya., ZVIRGZDIN'SH, F. P., ZIYEDIN'SH, V. Yu., KOTOVICH, L. L., OPMANIS, I. E., RODE, V. S., RODE, E. E., SPALVIN', A. P., SHLIKHTE, Ya. Yu., EGLITIS, A. E. and YANBITSKIY, R. A.

[Abstract] The OMEGA-2M special-purpose processor is intended for solution of scientific and engineering problems which reduce to nonlinear three-dimensional field equations. Such problems are involved in crude oil and natural gas prospecting and in filtration of underground water as well as in natural and engineering structures with electric, magnetic, thermal, and other field distributions. This processor is adapted for use with YeS Unified System computers. It reduces typically to one hundredth the machine time for solving a boundary-value problem, capable of performing up to 80 million operations per second during parallel processing of data contained in a matrix of 512 programmatically controlled nodal analog processors (their number can be increased to 16,384). The OMEGA-2M is furnished with necessary software as well as test, diagnostic, and maintenance equipment. It is the prototype of a YeS 2705 Unified System special-purpose processor being developed by the International Commission for Cooperation of CEMA Countries in Computer Technology.

[119-2415]

#### SYSTEM OF COMMAND FOR KR580IK80 MICROPROCESSOR USED WITH MICROCOMPUTERS

Moscow RADIO in Russian No 10, Oct 82 pp 24-28

ZELENKO, G., PANOV, V. and POPOV, S.

[Abstract] The instruction set for the microprocessor is outlined and described. All instructions are given in English mnemonics and binary (hexa-decimal). The number of machine cycles of each instruction is not noted, but brief descriptions of the instructions are presented. The concept of an interrupt and the action of the enable and disable interrupt instructions are to be presented in a future article. References: 2 Russian.

[125-6508]

## CONTROL SYSTEMS

UDC 621.396

### LOCKING BAND OF FREQUENCY SYNTHESIZER WITH FIRST-ORDER PULSE-PHASE AUTOMATIC FREQUENCY CONTROL LOOP

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received after completion 16 Feb 82) pp 42-44

MALINOVSKIY, V. N.

[Abstract] The dynamic performance of an automatic frequency control system for frequency synthesizers with "sampling-storing" pulse-phase detector and variable-quotient divider is described by a nonlinear difference equation and is analyzed in the discrete phase plane. Switching curves are plotted and the locking band is established, first from "above" and then from "below". In the case of a trapezoidal characteristic there exist quasi-periodic limit cycles and a periodic limit cycle of the first kind is possible, in the case of a triangular characteristic there are possible only periodic limit cycles of the second kind. The constraints on the parameters  $\beta = S_y E T_0 / 2 - N$  ( $S_y$  - slope of modulation characteristic of controlled oscillator,  $E$  - maximum detector output voltage,  $T_0$  - reference-generator pulse repetition period,  $N$  - divider quotient), namely boundaries of its forbidden band, are determined which in turn determine the existence of limit cycles. Figures 6; references 3 Russian.  
[101-2415]

## ELECTRICAL INSULATION

UDC 621.314.222.6.3.048:531.781.2

### MAXIMUM PRESSURE ON INSULATION MATERIALS IN WINDINGS OF LARGE POWER TRANSFORMERS

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 82 (manuscript received 14 Jan 82)  
pp 16-20

NOSACHEV, V. A., engineer, and SOKOLOVA, L. I., engineer, VIT [probably All-Union Scientific Research, Design Engineering and Technological Institute of Transformers]

[Abstract] For the purpose of evaluating the strength of insulation materials in transformer windings, a method is proposed for determining the maximum pressure on them and the deformation caused by mechanical and electrical forces. The problem reduces to calculation of four coefficients accounting, respectively, for pressure risers caused by: 1) Reduction of conductor bearing area to allow room for insulation layers; 2) Reduction of conductor cross-sectional area by rounding or corners; 3) Displacement of conductors in adjacent coils relative to one another; and 4) Nonuniform distribution of the axial force over the conductors of a coil. Subsequent calculations are based on geometrical relations and the Fuss-Winkler hypothesis regarding proportionality of forces and deflections, taking into account mechanical and thermo-physical properties of vacuum-heat treated insulation. Deflections are determined from the canonical equation for a beam on an elastic base  $d^4w/dx^4 + 4\beta^4 w = 0$  ( $\beta = \sqrt{K/4EI}$ ). Finally, both maximum and mean pressure on the critical components of insulation are obtained. Figures 3; tables 3; references: 3 Russian.

[104-2415]

UDC 621.315.61.001.5:536.483

### PRESENT STATUS OF RESEARCH ON ELECTRICAL INSULATION FOR CRYOGENIC DEVICES

Moscow ELEKTRICHESTVO in Russian No 9, Sep 82 (manuscript received 29 Jun 81)  
pp 37-43

KANISKIN, V. A. and SEREDA, G. G., Leningrad Polytechnic Institute

[Abstract] Continuing research on the electrical and other characteristics of polymer materials used for insulation in cryogenic devices covers dielectric

losses, electric strength, aging and life at temperatures over the 4.2-300 K range at commercial to microwave frequencies. Dielectric losses include "residual" background losses, charge injection and electron transition losses, electrostriction losses, and relaxation or oscillation losses associated with movement of dipoles, atom groups, and molecule chains. Available data on the short-duration electric strength reveal that it decreases with increasing field frequency and increases with increasing insulation thickness. Available data on the insulation life reveal that it is shorter under higher voltage and longer at lower temperature. The major processes governing the behavior of cryogenic insulation are partial discharges in insulation impregnated with fluid and thermocryocycling. Partial discharges attenuate in time and the voltage dependence of their repetition rate is weaker in dielectrics with higher surface and volume resistance, with lower mobility of free charges, and with denser gas in cavities. Thermocryocycling decreases the electric strength of insulation. Technical and statistical research data serve as basis for proper selection of cryogenic insulation material and system. Both film and bulk insulation are of interest and materials studied so far range from polyethylenes and polypropylenes to polyamides and polyimides. Figures 4; tables 8; references 33: 17 Russian, 16 Western (1 in translation).

[108-2415]

UDC 621.382

#### INVESTIGATION OF PROPERTIES OF NEW ELECTRON RESISTS

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82 (manuscript received 17 Dec 81) pp 483-486

ALEKSANDROV, Yu. M., VALIYEV, K. A., VELIKOV, L. V., GRIBOV, B. G., DUSHENKOV, S. D., MAKHMUTOV, R. Kh., MOZZHUKHIN, D. D., PLESHIVTSEV, A. S., SELIVANOV, G. K., USTINOV, N. Yu., and YAKIMENKO, M. N., Physics Institute, USSR Academy of Sciences

[Abstract] This brief communication investigates the sensitivity contrast and resolution of three types of electron resists. These are designated as MMA-MAK (copolymer methylmethacrylate and methacrylate kislota), GMA-EMA (copolymer glitsidilmekrila and etilmekrilot [Cyrillic]) and IMMA. IMMA is a poly-methyl methacrylate, the use of which is described in the present communication for a comparison of its properties with those of new resists. The time required for drying and development of the three resists mentioned above are shown in Table I of the communication. Data with respect to the sensitivity and contrast of the results of the investigations, obtained on the basis of their characteristic curves, are shown in Table II. A comparison is made of the resolution of MMA-MAK and IMMA during their use as electron resists and X-ray resists. Figures 3; references 5: 3 Russian, 2 Western.

[24-6415]

CONDUCTIVITY OF STRUCTURES OF METAL-DIELECTRIC-SEMICONDUCTOR AFTER BREAKDOWN  
OF DIELECTRIC FILM

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82 (manuscript received  
17 Dec 81) pp 451-452

STEPANOV, G. V., MUKAILOV, N. S., SHEVCHENKO, O. F., MALAKHOV, V. A., Institute  
of Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] This brief communication investigates the conductivity of metal-dielectric-semiconductor structures after breakdown of the dielectric layer. The measurements were made on the structure Al-SiO<sub>2</sub>-Si. The SiO<sub>2</sub> was  $\sim$  100-150 Å thick. After breakdown the conductivity of the structure had a strongly expressed rectifying nature. Under the assumption that with breakdown an Al-Si contact is formed, volt-ampere characteristics in Schottky coordinates are constructed. A typical volt-ampere characteristic of the structure Al-SiO<sub>2</sub>-Si after electrical breakdown of the dielectric film is shown in Figure 1. Figure 2 shows a typical experimental dependence of spreading resistance on voltage at the Al-Si contact. Figures 2; references 3:  
2 Russian, 1 Western.

[24-6415]

## ELECTRON DEVICES

UDC 621.382

### CRYOTRONS ON BASIS OF ONE-DIMENSIONAL DISTRIBUTED JOSEPHSON CONTACT

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82  
(manuscript received 24 Dec 80) pp 413-417

BAKHTIN, P. A., LAPIR, G. M., MAKHOV, V. I., SAMUS', A. N., SEMENOV, V. K.  
and TYABLIKOV, A. V.

[Abstract] Some preliminary results are presented on the development and investigation of Josephson cryotrons based on a one-dimensional distributed contact, and, in particular, on the basis of bridges of variable thickness with connectors of normal metal. The special features of the cryotron's construction are considered and figures showing the construction are presented. The possibility is shown of obtaining cryotrons with a given form of control characteristics by means of a spatial separation of the transfer and control currents. The principles of cryotron construction discussed are also useful for other types of Josephson contacts. Figures 5; references 7: 4 Russian, 3 Western.

[24-6415]

UDC 621.382.2

### PLASMA OXIDE FILMS ON CHLORINE-PLASMA ETCHED SILICON

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I  
TEKHNICHESKIKH NAUK in Russian No 4, Jul-Aug 82 (manuscript received 1 Mar 82)  
pp 40-46

BEKERIS, Yu. Ya., BENDER, R. B., VIRTMANIS, A. S., MIKELSON, A. O.,  
FREYBERGA, L. A., EGLITIS, I. E. and EYMANIS, I. A., Physical Power Engineering  
Institute, LaSSR Academy of Sciences

[Abstract] An investigation is made of optical and electrophysical properties of films less than 50 nm thick formed in RF oxygen plasma at 13.56 MHz on silicon substrates activated by chlorine-plasma etching. The substrates were n-Si with orientation (111), resistivity 0.5-4.5  $\Omega\cdot\text{cm}$ . Oxidation of the etched

surface was done at pressure in the oxygen RF plasma chamber of  $7 \cdot 10^{-4}$  mm Hg, the current through the specimen being  $10 \mu\text{A}/\text{cm}^2$ . The parameters of the films were determined by ellipsometry. It was found that film properties are determined by the parameters of the RF plasma during etching and oxidation. Excess silicon causes defects with reduced breakdown voltage, increasing the fixed charge of the interface and making it more nonuniform with respect to area. Charge transfer in films 8-50 nm thick involves pore conductivity, electron conductivity via absorption centers resulting from water absorbed in micropores, and Mott transition with activation energy of 0.06-0.07 eV. Frenkel conductivity is observed in fields stronger than  $10^5 \text{ V/cm}$ . Annealing in vacuum at  $700^\circ\text{C}$  reduced water sorption in the films, but does not eliminate it. Such annealing does not appreciably change the defect structure determined by breakdown voltage. Figures 6; references 9: 5 Russian, 4 Western.

[58-6610]

UDC 621.382.323

#### POWER FIELD-EFFECT TRANSISTORS IN LOW-FREQUENCY AND HIGH-FREQUENCY POWER AMPLIFIERS

Moscow RADIOTEKHNIKA in Russian No 9, Sep 82 (manuscript received 5 Jan 82)  
pp 13-22

D'YAKONOV, V. P.

[Abstract] Power field-effect transistors cover a wide range of devices from the MOS devices KP901 and KP902 first developed in the Soviet Union during the nineteen seventies to those developed subsequently abroad (D-MOS, Z-MOS, V-MOS, HEXFET, SIPMOS), each with its peculiar source-gate-drain on substrate and current-path configuration. Their structural and performance, specifically current-voltage characteristics, have been designed to match various applications such as power amplifiers. The latter include: 1) Single-sided microwave, high-frequency, and low-frequency (high-fidelity audio) power amplifiers; 2) Push-pull parallel-balanced transformer-coupled, series-balanced with phase-inverting transformer and galvanic coupling to load, transformerless with phase-inverting complementary bipolar transistors, and transformerless with complementary MOS transistors; 3) Class D power amplifiers. The common features of all power amplifiers using field-effect transistors are high power rating (up to 100 W and higher), facilitated by introduction of MOS transistors with vertical structure, high voltage rating (up to 1 kV), high reliability, low nonlinear distortion, and high efficiency (up to 95% in the case of class D power amplifiers). Figures 11; references 33: 18 Russian, 15 Western.

[101-2415]

INDUSTRIAL ELECTRONICS & CONTROL INSTRUMENTATION

UDC 519.2

CONSTRUCTION FOR CONTROLLING FORCE FIELDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian  
No 4, Jul-Aug 82 (manuscript received 11 Jun 80) pp 153-159

ZUBOV, V. L., Leningrad

[Abstract] A method is proposed for constructing controls which transpose a mechanical system into a predetermined position in a space of configurations. Such controls may be realized by Coriolis and relative forces of inertia that arise as a result of purposefully organized relative motion of a concomitant system of material points associated with the main mechanical system. The author also suggests an approach to solution of control problems in systems with an infinite number of degrees of freedom based on constructing controlling force fields that produce a change in the space of configurations determined by a given velocity field. References: 3 Russian.  
[60-6610]

UDC 621.313.175.335:621.314.2

LONGITUDINAL MOTION OF HAND OF AUTONOMOUS ROBOT DURING MULTIPONT POSITIONAL CONTROL

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
(manuscript received 25 May 82) pp 57-63

AFONIN, A. A., BILOZOR, R. R. and GREBENIKOV, V. V., Institute of Electrodynamics, UkrSSR Academy of Sciences, Kiev

[Abstract] Linear electric motors are considered for driving robot servo-mechanisms, their advantage being the need for only one stage of electrical-to-mechanical energy conversion with resulting high reliability and efficiency. The performance of such a motor used for controlling the longitudinal motion of a robot hand with a single-voltage power supply is analyzed from the stand-point of the entire system, namely mechanical structure and force-displacement characteristic of the hand and electric circuit of the motor with auxiliaries.

The hand of an autonomous robot consists of a six-phase motor with movable core, tongs with drive, and wrist with drive. The motor phases are switched by booster control pulses from a master oscillator with regulation of the repetition rate, fed to the windings through a pulse distributor, a power amplifier, a boost control module, and a bank of six diodes in parallel. The power amplifier feeds the control module through six inductances in parallel shunted by two storage capacitors, one for odd phases and one for even phases. The control module is also fed directly from the pulse distributor. Current transients in the motor are calculated and the circuit components designed on this basis so as to ensure high response speed and high efficiency. Figures 4; references: 8 Russian.

[105-2415]

UDC 621.314.5.001.4

#### THYRISTOR-TYPE CONTROL SYSTEMS FOR ELECTRONIC HIGH-VOLTAGE COMMUTATORS

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 82 (manuscript received 14 Dec 81)  
pp 20-23

LIPATOV, V. S., candidate of technical sciences, and STARSHINOV, N. N.,  
engineer, Istra branch, All-Union Institute of Electrical Engineering imeni  
V. I. Lenin

[Abstract] Thyristors with short switching time and high  $di/dt$ ,  $dv/dt$  ratings are now produced in the Soviet Union. These TCh and TChI thyristors are particularly suitable for rectifier control handling 20 kW or more power. The shunting circuit can be connected either on the load side or on the supply side, respectively, to the cathode or the anode of the main thyristor. The latter connection is preferable for high-speed operation, which also requires a current limiting device in this case. Cutoff of a commutating thyristor is effected either by an LC circuit in parallel or by a quenching capacitor in series. Fast recharge of the input capacitor during firing of the auxiliary thyristor is achieved by shunting the main thyristor with a diode in reverse. Reliable cutoff of the main thyristor is achieved by means of two voltage dividing resistors and a series capacitor. These schemes have been refined for forming voltage pulses with steep edges than, in the case of capacitive load, an initial voltage spike. The principle has been incorporated in the ELV100/50 electron-beam rectifier controlling a commutator for protective disconnection of the voltage supply from a tokamak-type atom injector in a thermonuclear plant. Figures 5; references 8: 6 Russian, 2 Western.

[104-2415]

UDC 621.314.027.8.001.2

PROBABILITY ANALYSIS OF REVERSE VOLTAGES ACROSS THYRISTORS IN SERIES DURING CUTOFF

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
(manuscript received 22 Dec 81) pp 22-26

GLAZENKO, T. A., Institute of Precision Mechanics and Optics, Leningrad, and BUDILOV, B. A., Scientific Research Institute of Direct Current, Leningrad

[Abstract] The distribution of reverse voltages during the cutoff period across thyristors in a series bank shunted by RC-circuits which divides these reverse voltages, is analyzed probabilistically, this distribution depending on the random lifetime distribution of minority carriers (holes) in wide n-region bases and on the capacitances in the RC-circuits. The analysis is based physically on the theory of turn-off in four-layer structures and statistically on a normal distribution of hole lifetimes. Measurements and data processing in the form of histograms have yielded such a distribution with mathematical expectation  $m_{\tau} = 14.39 \mu s$  and standard deviation  $\sigma_{\tau} = 4.44 \mu s$  for T150 wide-base thyristors. It is possible to redesign the thyristor bank so as to decrease the capacitances in the RC-circuits without increasing the overall package size, namely by limiting the range of lifetime dispersion. Assuming a normal distribution of hole lifetime in the total thyristor population, the distribution of reverse voltages in the truncated lot is again calculated. Typical results are given for a lifetime distribution with  $m_{\tau} = 13.7 \mu s$  and  $\sigma_{\tau} = 2.43 \mu s$  after renormalization, the necessary capacitance having decreased from 0.3 to 0.16  $\mu F$ . Figures 2; references 7: 4 Russian, 3 Western (2 in translation).

[105-2415]

UDC 621.316.84.001.1

OVERVOLTAGE PROTECTION OF HIGH-VOLTAGE THYRISTOR RECTIFIERS BY MEANS OF ZnO-VARISTOR DEVICES

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
(manuscript received 25 Nov 80) pp 45-50

TIMOSHENKO, A. L. and TOLSTOV, Yu. G., State Scientific Research Institute of Power Engineering, Moscow

[Abstract] A large lot (150 samples) of SN2-1/2 ZnO-varistors, in the form of 3-6 mm thick disks 29-30 mm in diameter with nominal rating of 500-600 V and highly nonlinear current-voltage characteristic  $V = AI^{\alpha}$ , was tested for suitability as overvoltage protection for high-voltage thyristor rectifiers. The dependence of maximum permissible current amplitude and energy dissipation on the duration of a current pulse were measured. They were also tested with RVMG dischargers. The results are now interpreted in terms of theoretical

voltage-current and energy-time relations as well as from the standpoint of application in protective circuits. Their major drawback is a low maximum permissible continuous operating current (1 mA), but this difficulty can be overcome by using a bank of such varistors in series with a switching device such as a spark gap across the rectifier. Figures 4; references 8: 6 Russian, 2 Western.  
[105-2415]

UDC 621.382

## OUTLOOK FOR DEVELOPMENT OF SEMICONDUCTOR POWER ELECTRONICS

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 8, Aug 82 pp 53-58

TUCHKEVICH, V. M., academician, and CHELNOKOV, V. Ye., doctor of technical sciences

[Abstract] An examination is made of the current status and prospects for development of the power conversion equipment industry in the USSR. This industrial sector produces converters that serve as an intermediate link between producers and consumers of electric energy. At present, 37% of all generated electric energy in the USSR is utilized in converted form, and this figure is expected to rise to 50% by 1985. Major users of this equipment are electric transportation, the metallurgical industry, the power industry, construction, machine building, chemistry and petrochemistry. Anticipated new areas of use are high-voltage converters for superhigh-voltage DC power transmission lines, inverter devices for industrial MHD generators and other facilities for direct conversion of thermal, chemical and nuclear energy to electric energy, controlled frequency AC converters for electroslag melting, conversion facilities for future high-speed surface transport, high-voltage converters to compensate for reactive power in AC transmission lines, and devices for ion hardening of friction couples. The component base for all these secondary converters is provided by semiconductor power electronics. Most semiconductor power devices are now based on silicon single-crystal plates. Such devices can handle voltages from a few hundred to thousands of volts, currents from tens to thousands of amperes at speeds from microseconds to fractions of a microsecond. However, despite ingenious efforts to extend the capabilities of silicon power devices, the limitations imposed by the properties of the material itself are already being felt. The search for new materials has led to considerable study of gallium arsenide and its solid solutions. Although gallium arsenide has somewhat higher thermal losses than silicon, this disadvantage is more than offset by two positive factors: a wider forbidden band and higher critical electric field. Thus, devices with pn junctions based on GaAs can be made with parameters in the aggregate far superior to those of Si devices. In addition, GaAs can be used for producing heterojunction devices. Research is just starting on the possibilities of silicon carbide for semiconductor power conversion devices. This material has an even wider forbidden band than either silicon or gallium arsenide, and heavy doping should enable production of devices that can operate at pn junction temperatures up to 1000°C.

Figures 4.

## INSTRUMENTATION & MEASUREMENTS

UDC 621.3.014.332;551.594.221

### RESULTS OF LIGHTNING CURRENT AMPLITUDE MEASUREMENTS

Moscow ELEKTRICHESTVO in Russian No 9, Sep 82 (manuscript received 27 Oct 81)  
pp 53-54

RAKOV, V. A., engineer, and DUL'ZON, A. A., candidate of technical sciences,  
Scientific Research Institute of High Voltages at Tomsk Polytechnic Institute

[Abstract] Lightning currents were measured telemetrically in Kireyevsk (Tomsk oblast, Western Siberia) during the 1980 storm season. Their amplitudes were determined according to the relation  $I_M = (27.0 - 26.5e^{-0.07D})DE_M \cdot 10^{-2}$ , the Uman formula with a correction factor depending on distance D. The distance D (km) from the discharge was determined from the time between lightning flash and thunder clap, the maximum vertical component of electric field intensity  $E_M$  (kV) at the point of pickup was measured on a memory oscilloscope, the current amplitude  $I_M$  (kA) was only known to vary within the 0.9-113 kA range. A subsequent statistical evaluation of the readings, fundamental components of 83 negative discharges in 6 thunderstorms with analysis of measurement errors and a Pearson conformance test, has yielded a log normal distribution of lightning current amplitudes for this region with mathematical expectation  $m = 0.927$  and standard deviation  $\sigma = 0.483$  beyond the D = 25 km range. Figures 1; references 6: 3 Russian, 3 Western (1 in translation).

[108-2415]

UDC 621.314

### CONVERTERS OF SYNCHRO AND SINE-COSINE RESOLVER ANGLE TO DIGITAL CODE

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 27-29

DOMRACHEV, V. G., doctor of technical sciences, and PODOLYAN, V. A., engineer

[Abstract] Design and performance parameters of angle encoders for synchros and sine-cosine resolvers (rotating transformers) manufactured by Analog Devices Inc (US) are given. The high-precision models (+30-+0.5' single readout and down to +0.05' double readout) models 1752/53/56/57, 1604,

1700/02, 1725/26, 1741/42 are of interest, a typical tracking system including such an encoder with a synchronous detector as well as input-signal transformer and reference-signal transformer is shown and described. Figures 2; tables 1. [109-2415]

UDC 621.382

#### LINEARITY CONSTRAINTS ON INPUT STAGE OF CHARGE-COUPLED DEVICES

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian Vol 4, No 6, Nov-Dec 82  
(manuscript received 22 Dec 80) pp 97-99

YEPIFANOV, A. A., FROLOV, O. S. and PEREVERTAYLO, V. L.

[Abstract] An input stage for charge-coupled devices with a buried channel is proposed which will improve the linearity of such devices without loss of speed. Both measuring and control electrodes are made with surface transfer and only the rest, including the transmitting circuit and two other electrodes are built on a structure with buried channel. This construction accelerates the usually slow equalizing process after a relatively fast swamping of the measuring potential well. Making both electrodes shorter compensates for rerouting to the surface channel. The transfer characteristics  $Q = f(\Delta V) / V_b$  [Q - charge of holes,  $\Delta V = V_b - V_s$ ,  $V_b$  - bias voltage,  $V_s$  - analog signal voltage] are calculated from the solution to the Laplace-Poisson equation for the electric potential distribution with appropriate boundary conditions at the four electrodes and at the oxide-semiconductor interface (assuming zero potential in the substrate). These characteristics are highly linear (within 1%) in the large-signal range  $\Delta V > 1.5$  V and highly nonlinear (beyond 10%) in the small-signal range  $\Delta V < 1.5$  V, with a quasi-linear intermediate range. A typical device is built on an n-Si substrate ( $n = 10^{15} \text{ cm}^{-3}$ ) with a 0.65 micrometer wide buried p-type channel ( $p = 2 \cdot 10^{16} \text{ cm}^{-3}$ ), a 1200 Å oxide film, and 8 micrometer long electrodes. Figures 2; references 11: 3 Russian, 8 Western. [119-2415]

UDC 621.382.008(088.8)

MULTIPROBE MEASUREMENT DEVICE FOR DETERMINING CONCENTRATION DISTRIBUTION AND MOBILITY OF CHARGE CARRIERS IN SEMICONDUCTORS

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I TEKHNICHEISKIKH NAUK in Russian No 4, Jul-Aug 82 (manuscript received 9 Feb 82) pp 36-39

DREYMANIS, E. A., KLOTYN'SH, E. E., MIKOSS, A. Ya., NADONENKO, P. I. and PETROV, V. K., Physical Power Engineering Institute, LaSSR Academy of Sciences; Tallinn Electrical Equipment Plant imeni M. I. Kalinin

[Abstract] A multiprobe measurement facility is proposed for determining distribution of the Hall effect and electrical conductivity. The unit contains a base, current conductors, potential probes accommodated in dielectric guides, and a moving electrocontact module which slides in these guides. The plug unit has at least two rows of probes in the form of springs with rounded free ends, and at least two matching registration holes. Moving current leads with slots are located on the base. The specimen is oriented on this base by means of specially applied registration marks. Current and measurement contacts are produced on the specimen by photolithography. The design of the electrocontact module enables simultaneous setting of all probes on contact areas of the specimen without additional displacement relative to the specimen. Measurement consists of determining the potential difference between various pairs of probes as current is passed through the specimen with and without a magnetic field, followed by calculation of the concentration of charge carriers and their mobility. Computerizing the equipment enables measurement of voltages between 2000 pairs of probes, processing results and graph-plotting the distribution of electric properties through the specimen in a matter of 3 minutes. Figures 3; references 21: 17 Russian, 4 Western.

[58-6610]

UDC 621.387.322.311.004.1

APPLICATIONS FOR IMG-1 MATRIX-TYPE GAS-DISCHARGE INDICATING DEVICE AND PROSPECTS FOR ITS FURTHER DEVELOPMENT

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 23-25

LOBAN, V. I., engineer, GLUBOKOV, G. G., engineer, KARPOV, V. G., engineer, and KOROSTELEV, I. N., engineer

[Abstract] The first (since 1978) series produced matrix-type gas-discharge indicating device IMG-1 consists of a luminous screen of  $50 \text{ cd/m}^2$  brightness, an array of  $10^4$  glow tubes mounted in a dielectric panel, two sets of electrodes (100 cathodes and 100 anodes), and a commutator with a control module for each set. The device operates with a dual d.c. voltage supply (5 and 250 V). The cathode commutator is a 2-stage 100-output decoder which sweeps an image on

the screen, the first stage consisting of standard logic elements and the second stage consisting of VT108-VT207 transistor switches, controlled by 2-digit binary-decimal code signals. The anode commutator matches information signals to the high-voltage panel. The device is used by approximately 200 enterprises in programmable numeric control of machine tools, in computer input-output and terminal modules, in atomic electric power plants for reactor inspection, in spectrum analyzers as well as digital oscilloscopes and recording instruments, also in medicine, in education, and in physical sciences research. A typical mode of operation is display of curves and histograms. The IMG-1 was exhibited and awarded the Seal of Excellence, and already several thousand units have been produced and certified. Its use in production processes and for preventive diagnosis has contributed to the national economy a saving of at least 8 million rubles and an extra energy output of 50 million kW.h annually. Further developments of this device are in the field of special -purpose modifications. Figures 5; references: 8 Russian. [109-2415]

UDC 621.387.322.311.004.1

MATRIX-TYPE GAS-DISCHARGE INDICATING DEVICE IMG-1-03

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 25-27

KOROSTELEV, I. N., engineer, MATSYUK, V. A., engineer, and SHTURMAN, A. N., engineer

[Abstract] The series produced matrix-type gas-discharge indicating device IMG-1-03 has a capacity of 10x16 spaces for displaying letters of the Russian and the Latin alphabets, Arabic numerals, and special symbols. It also includes, in addition to the standard IMG-1 module, a special input module, an indicator lighting trigger, and a sweep counter. The input module consists of a set of buffer switches with an erasing circuit, a code recording control circuit, an address counter, a 12/250 V d.c. converter, a direct-access memory, a read-only memory, a 7x10 buffer memory, a switch, a generator, a pen control mechanism with counter, and a scaler. The device is designed for operation in the recording mode and in the display mode. Its screen lights up as orange-red with a brightness of 50 cd/m<sup>2</sup> and a contrast of 70% minimum in ambient light at a 200 lux level. Its two major applications are in programmable numeric control of machine tools or automatic manipulators and in diagnostic information processing. Figures 4; tables 1. [109-2415]

UDC 681.325.5-181.48

EQUIPMENT FOR DEBUGGING OF MICROPROCESSOR K580IK80 PROGRAMS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 31-32

GLADKOV, A. M., engineer, and KHOKHLOV, Yu. V., engineer

[Abstract] A scheme has been developed for debugging microprocessor K580IK80 programs by the step method, with possibility of command execution and of direct access to memory during lockout of the program interruption mechanism. The equipment necessary for implementation of the debugging procedure includes a set of state indicators and control panels, among the latter a completely hardware-oriented "front" panel, with possibility of direct access to any program segment or initial cell. The debugging equipment operates in the "microprocessor readiness" mode, implemented by two AND gates, two SDCR-input/Q-output triggers, three step switches, a phase generator, a test sample generator, a comparator, and an address presetter. These program debugging procedure and equipment have been added to a K580IK80 microprocessor for measurement of cryogenic temperatures. Figures 1; tables 1; references: 4 Russian.

[109-2415]

## MICROWAVE THEORY & TECHNIQUES

UDC 621.376.029.64:621.3.049.72

### HETERODYNE METHOD OF DETECTING MICROWAVE SIGNALS WITH SUPERCONDUCTING MICROFILM DEVICES

Moscow RADIOTEKHNIKA I ELECTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 30 Mar 81) pp 2226-2229

KRUT'KO, A. P. and SULIMA, V. S.

[Abstract] Detection of microwave signals by the heterodyne method was studied experimentally with superconducting microfilm devices. The microwave signal sources, with waveguide-stripline comb transitions were built on thick (100 nm)  $\text{Nb}_3\text{Sn}$  or NbN films and the superconducting microfilm devices were built on thin (10-20 nm) NbN films. The latter were produced by the epitaxial process. The current-voltage characteristics of these microfilm devices and the frequency characteristic of their noise were measured at temperatures from 7.25 to 10.55 K, in the heterodyne detection mode and in the square-law detection (without heterodyning) mode. A high negative differential impedance was recorded at the operating point (current 0.35 mA, bias voltage 2.1 mV) at 7.25 K, with a 7.3 dB loss in the 8 mm wave band. At this point in the absence of microwave power there was also recorded a noise component, in addition to thermal noise, associated with fluctuations of the microfilm temperature and attendant voltage fluctuations in the resistive current-carrying region. The low-frequency noise at temperatures above the superconducting transition point increases linearly with increasing bias current. At a constant bias current the overall noise level first decreases as the frequency increases up to approximately 200 kHz and then remains constant as the frequency increases further. The authors thank S. A. Peskovatskiy for discussing the results, F. I. Korzhinskiy for assisting with the preparation of specimens, and V. A. Obolonskiy for assisting with the measurements. Figures 5; references 9: 6 Russian, 3 Western (1 in translation).

[116-2415]

ACTIVE MICROWAVE DEVICES WITH DISTRIBUTED PARAMETERS (REVIEW)

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 15 Sep 80) pp 1665-1682

LYUBCHENKO, V. Ye., MAKEYEVA, G. S. and NEFEDOV, Ye. I.

[Abstract] The main trends in development of microwave techniques at the present time are their application to millimeter and submillimeter waves, and circuit integration. These developments involve research in semiconductor physics and technology as well as in waveguide technology and circuitry. The main advantages of using active elements with distributed parameters here are: 1) The latter can be easily made compatible with those of transmission lines; 2) Both power rating and band-width can be increased by changing from concentrated to distributed interaction in a device; and 3) Devices with distributed parameters can be made multifunctional. Types of transmission lines suitable and promising for use with such active devices are strip lines, slot lines (asymmetric with or without "overlap" of shields), waveguide-slot lines, coplanar waveguides, metallic waveguides, dielectric wave-guides, reflecting waveguides and insulated waveguides. Various physical phenomena serve as a basis for design and construction of active devices with distributed parameters, the most prominent among them are: amplification of space-charge waves in semiconductors with intervalley electron transitions and attendant negative differential conductance, amplification of electromagnetic waves in such semiconductors during transverse drift of electrons (use of matching regions at input and output and stabilization with thin conducting film on back side of semiinsulated base contributing to improved performance of coplanar amplifiers), amplification of traveling wave by beam of drifting charge carriers in the retardation zone of semiconductor analog of traveling-wave tube, and frequency conversion during propagation of electromagnetic waves through nonlinear media. Active devices with distributed parameters are, furthermore, feasible on p-n, p-i-n, MOS structures, on superconducting junctions, and on semiconductor substrates with MOSM structure or Schottky barrier. A variant of active devices with distributed parameters are active devices with periodic structures consisting of elements with lumped parameters. Figures 12; references 128: 63 Russian, 65 Western (2 in translation).

[103-2415]

UDC 621.382.537.533.35

NEW METHOD FOR INVESTIGATING RESOLVING POWER OF ELECTRON RESISTS WITH AID OF  
SUBMICRON MASK-TEMPLATE IN CONTACT WITH PROTECTION LAYER

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82  
(manuscript received 17 Dec 81) pp 447-450

VALIYEV, K. A., VELIKOV, L. V., DUSHENKOV, S. D., MAKHMUTOV, R. Kh.,  
RAKOV, A. V. and USTINOV, N. Yu., Physical Institute, USSR Academy of Sciences

[Abstract] This paper proposes an essentially new method of investigating the resolving power of electron resists. It is possible to obtain a figure (illustration) of submicron dimensions in a layer of resist. The resist is irradiated by an electron beam through a mask--template in contact with it. In this case the transverse dimensions of the electron beam used can significantly exceed the typical dimensions of the template elements, and the electron beam can be nonfocused. It is proposed to use nuclear filters as a mask-template. These filters are obtained at heavy ion accelerators. The results of the experiments presented confirm the prospects for the methods described. Figures 3; references 3: 2 Russian, 1 Japanese.

[24-6415]

UDC 621.385.6

TWO METHODS OF ANALYZING MULTIFREQUENCY OPERATION OF MICROWAVE AMPLIFIERS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 21 Apr 81) pp 1813-1817

LUKIN, K. A.

[Abstract] Two methods of analyzing the multifrequency operation of microwave amplifiers are compared: one based on representing the sought time function in the form of multiple Fourier series and using the law of charge conservation, and one based on the theorem of irregular--sequences. The latter algorithm can be simplified by also using the law of charge conservation. Both methods are shown to be mathematically equivalent, as demonstrated on the calculation of partial current components in an electron beam interacting with an arbitrary number of synchronous waves with different frequencies and wave numbers. The efficiency of these algorithms is evaluated relative to the method of large particles. Recommendations are made on this basis for simulating the motion of electrons in the case of commensurable and incommensurable frequencies respectively, to ensure an accurate design. The author thanks V. P. Shestopalov, A. S. Bakayu, B. Ye. Zhelezovskiy, V. M. Pikunov and V. A. Cherepenin for helpful discussions. References 17: 15 Russian, 2 Western (in translation).

[103-2415]

UDC 621.385.6

SUPPRESSION OF BACKWARD-WAVE OSCILLATIONS IN MICROWAVE DEVICES WITH  
NONHOMOGENEOUS RETARDING SYSTEM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 25 May 81) pp 2215-2221

GOL'TSOVA, Yu. K., KOVALEV, N. F. and REZNIKOV, M. G.

[Abstract] A nonhomogeneous retarding system is considered as a means of suppressing backward-wave oscillations in a traveling-wave tube and of parasitic modes in backward-wave tubes. The principle is demonstrated on a one-dimensional model of a backward-wave tube, disregarding the initial energy spread of electrons and the effect of asynchronous harmonics. Both ends of the retarding system are assumed to be matched, with negligible reflections and reradiation by inhomogeneities within the system. The analysis is based on a self-adjoint of two linearized differential equations for the slow amplitude of the longitudinal electric field component in the traveling wave and the alternating current component in the electron beam, respectively. Losses and presence of a high-frequency space charge are considered. The eigenvalues of these equations are proved to be mirror-invariant in the case of a backward-wave tube with constant coupling impedance and linearly varying deviation of wave phase velocity from the constant component of electron velocity. The starting performance of such a tube is also calculated.

Figures 3; references: 4 Russian.  
[116-2415]

UDC 621.385.6

EFFICIENCY OPTIMIZATION OF MULTICAVITY KLYSTRONS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 20 Nov 80) pp 2426-2434

AKSENCHIK, A. V., KOLOSOV, S. V., KURAYEV, A. A. and SHESTAKOVICH, B. P.

[Abstract] A theoretical study on maximizing the efficiency of five-, six-, and eight-cavity klystrons for single-frequency operation was made on the basis of the one-dimensional nonlinear interaction model with correction of the space-charge parameter in each successive drift tube according to the velocity modulation level in the preceding cavity gap, by application of the Ovcharov-Solntsev theory of nonlinear space-charge waves and the theory of automatic control systems. Two-dimensional effects (stratification of electron beam and radial motion of electrons) have been disregarded for reasons of computer time economy and considering that attainment of highest possible efficiency requires these effects to be negligible. The optimization process involved calculating the dependence of maximum efficiency as well as of optimizable design and performance parameters on the current density in

the electron beam and on the width of cavity gaps. Radius of drift tubes and accelerating voltage were fixed, their selection depending on other factors such as range of operating wavelengths and mode of application. The results reveal that narrowing the cavity gaps and shortening the transit channel are necessary for optimizing the high-frequency field, the bunching process, and the energy transfer for maximum efficiency. Figures 3; tables 4; references: 17 Russian.

[117-2415]

#### APPLICATIONS FOR MICROCALCULATORS: RESULTS OF MINICONTENT

Moscow RADIO in Russian No 6, Jun 82 pp 30-33

Staff of RADIO, Moscow

[Abstract] New applications for microcalculators have been proposed by participants in a minicontest sponsored by the RADIO staff. Most interesting among them are the use of: 1) "Elektronika B3-23" as a pulse counter or secondometer times (Yu. Zal'tsman, RADIO Nos 5-6, 1981); 2) Use of "Elektronika B3-05" as an automatic reversible counter with programming module and complete automation (V. Ivolgin from Yuzhno-Sakhalinsk); 3) Use of Elektronika B3-18A" as chess-game timing clock (Yu. Pristinskiy from Krasnyy Liman and S. Kundyukov from Khar'kov); 4) Extension of functional capabilities of "Elektronika B3-23" beyond the four basic arithmetic operations by means of either combining functions of existing buttons or addition of buttons to normally open contactors for the K145IP11 arithmetic unit (Yu. Zal'tsman from Alma-Ata); and 5) Use of programmed "Elektronika B3-21" (Yu. Zal'tsman from Alma-Ata) or nonprogrammed "Elektronika B3-23" (S. Kornilova, I. Golubev, N. Zaretskiy from Yakutsk) in an electronic watch, the former with a simple external generator of minute pulse and the latter with a more intricate external counting device. All these devices include appropriate digital logic, trigger circuitry, and indication with microcircuit integration on printed-circuit boards. Other proposed new applications are automatic data input, programmed processing of digital data from keyboard or calculator memory, and data output to external devices. These applications require intricate hardware and, therefore, are not practical for radio amateur work.

Figures 5.

[118-2415]

NEW ACTIVITIES, MISCELLANEOUS

UDC 537.874.6

SINGULAR EDGE IN PROBLEMS OF DIFFRACTION BY INHOMOGENEITIES WITH GYROTROPIC MEDIUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 21 Oct 81) pp 2343-2349

POPOV, V. P.

[Abstract] Two-dimensional problems of diffraction by inhomogeneities with transversely magnetized gyrotropic medium are considered where a wedge of the gyrotropic medium, with any kind of boundary conditions at its planes, forms a singular edge, i.e., a nonintegrable field singularity when the magnetization level is sufficiently high. Such problems include, specifically, scattering of an H-wave by the air-ferrite interface and attendant anomalous losses in a rectangular waveguide. This problem is solved first for unidirectional magnetostatic waves in a flat waveguide partly filled with ferrite, then for a sectoral waveguide into which the former maps conformally as the external magnetic field changes direction and the unidirectional waves become sectoral ones. A special problem is taking into account a narrow gap between ferrite and electrically conducting wall, in which case a sectoral unidirectional wave transforms into a unidirectional slot wave. The region of anomalous losses shifts when the walls are magnetic instead of electrically conducting and it expands correspondingly in the case of both magnetic and electrically conducting walls on the edge. A general formula is given for the load impedance. Numerical solution of these diffraction problems with anomalous losses is generally feasible, if a large number of basis functions is included, but the nonintegrable singularity must be removed or the sectoral magnetostatic wave must be extracted from the edge region (its structure can usually be determined analytically). Because of the anomalous losses, it is meaningless to evaluate the accuracy of numerical solution on the basis of power balance between incident and reflected waves. Figures 5; references 8: 5 Russian, 4 Western.

[117-2415]

UDC 621.313.323.045:537.312.62

ASYNCHRONOUS STARTING OF SYNCHRONOUS MOTOR WITH SUPERCONDUCTING FIELD WINDING

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 82 (manuscript received 15 Oct 81)  
pp 40-42

SIGAYEV, V. Ye., engineer, VNIIelektromash All-Union Scientific Research  
Institute of Electrical Machine Building

[Abstract] Asynchronous starting of a two-pole synchronous motor with superconducting field winding is analyzed, such a starting being effected by interaction of eddy currents in symmetric rotor cages with the magnetic field of the stator while the superconducting winding is still open. The motor (stator) is assumed to draw power from an infinite source. Differential equations with respect to two orthogonal axes rotating in space at synchronous speed are solved in order to describe the transient process during starting. The results yield the torque, and current, necessary to ensure a sufficiently low pull-in slip (0.1-0.2). On this basis are determined the main design requirements, especially regarding the rotor cages, for a typical fan drive as well as the static torque-speed characteristic of the latter. Figures 3; tables 1; references 11: 8 Russian, 3 Western.

[104-2415]

UDC [621.314.6:537.312.62].001.24

THEORY OF TOPOLOGY-TYPE STATIC SUPERCONDUCTING CONVERTERS

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 82 (manuscript received 18 Dec 80)  
pp 33-36

ANTONOV, Yu. F., candidate of technical sciences, and KAZOVSKIY, Ye. Ya.,  
doctor, professor VNIIelektromash (All-Union Scientific Research Institute  
of Electrical Machine Building)

[Abstract] A topology-type static superconducting converter consists of a transformer with a set of magnetic, thermal, or mechanical switches in parallel branches of the secondary winding, the load being connected to the secondary winding in parallel with the switches. The latter convert alternating current induced in the secondary winding to direct current in the load. The converter operates as a magnetic flux pump when connected to a superconducting inductive load and as a plain rectifier when connected to a resistive load. Under real conditions it operates in the hybrid mode, which is analyzed here by treating each "pure" mode separately and then introducing necessary correction factors. The magnetic flux distribution in superconducting circuits is determined for the case of mechanical switches (resistance  $R_0 \rightarrow \infty$ ), whereupon the effect of a finite resistance  $R_0$  is evaluated. The results yield the basic performance characteristics of such a device, particularly the rate of current buildup in the load and the limiting load current. Figures 3; tables 1; references 10: 1 Russian, 9 Western.

[104-2415]

UDC 621.373.5.029.4

UNIFORM NOISE OF GUNN OSCILLATORS

Moscow RADIOTEKHNika I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 24 Nov 80) pp 2235-2239

BARMENKOV, O. A. and KUZNETSOV, A. S.

[Abstract] Noise in a Gunn oscillator with a high-grade diode is considered. The level of flicker noise in such a device is low and fluctuation stability depends on the noise level because of scattering of charge carriers in the semi-conductor. This noise was measured in an open half-wave waveguide chamber over the uniform range of the frequency spectrum, up to 30 MHz. It consists of frequency noise with an intensity of  $3 \cdot 10^{-3}$  -  $2 \cdot 10^{-2}$  Hz<sup>2</sup>/Hz and amplitude noise with an intensity of 170-180 dB/Hz, corresponding to shot noise with a 0.1 depression factor. Experimental data are compared with and found to agree with results of a theoretical analysis based on an equivalent circuit of a Gunn oscillator consisting of a harmonic current source shunted by a parallel combination of conductance and capacitance, both averaged over one high-frequency period. Microwave fluctuation of the diode current is regarded as the source of both frequency and amplitude noise within the given frequency range. On this basis a simple inverse relation is established between the Q-factor of a Gunn oscillator and its locking band  $\frac{2\Delta f}{f}$ , the latter easily measured under small-signal conditions, with a group of circuit parameters as the coefficient. Figures 2; references 3: 2 Russian, 1 Western (in translation).

[116-2415]

UDC 658.012.2"313"

METHODICAL BASIS FOR EVALUATING EFFECTIVENESS OF NEW TECHNOLOGY

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 82 pp 39-40

LEPE, L. N., candidate of economic sciences

[Abstract] A fresh methodical and methodological approach is proposed for evaluating the cost effectiveness of new technologies and, consequently, of scientific and technical progress. It is based on maximizing the useful output information and minimizing the necessary input information, with proper accounting for an differentiation of means of implementation financed by research funds, contracts, and credit, respectively. A systematic management of development planning is necessary, aided by appropriate and precise documentation and standards for evaluation of acutal results relative to expectations. References: 5 Russian.

[109-2415]

IMPROVING EFFICIENCY OF AUTOMATIC STATISTICAL DATA GATHERING AND PROCESSING SYSTEMS

Moscow VESTNIK SVYAZI in Russian No 12, Dec 82 pp 33-36

LAMM, G. B., department head, Main Computer Center, USSR Ministry of Communication

[Abstract] Introduction of automatic control systems has most significantly improved the efficiency of production and economic management. The main problem here is proper utilization of the computer for gathering and processing of statistical data to be then used at higher organizational levels. This is achieved most effectively by appropriate preparation of statistical data, the latter existing in various forms, for subsequent handling by computer hardware and software. Several variants of data management are possible, one including less efficient manual preparation and another being more completely technological but also more complex. Into consideration must be taken such factors as accountability, flexibility, and storage time. A new feature is teleprocessing, yet to be justified economically. Criteria based on cost analysis, in which machine time plays a very important role, must be established as a guide to ensure that progressive automation of data management and communication will proceed according to economic goals. [111-2415]

POWER ENGINEERING

UDC 621.313.322

SHIELDING OF STATOR END ZONES IN TURBOGENERATOR AGAINST LEAKAGE FIELDS  
ACCORDING TO STUDY ON PHYSICAL SCALED-DOWN MODEL

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82  
(manuscript received 8 Jun 81) pp 64-69

SMORODIN, V. I., KARATSUBA, A. S. and RUDENKO, L. N., Institute of Electrodynamics, UkrSSR Academy of Sciences, Kiev

[Abstract] An experimental-theoretical study was made of the stator end zones in a turbogenerator, specifically the electromagnetic shielding, for the purpose of estimating their state under load and optimizing the design. The end stacks of the stator core require shielding against magnetic leakage fields of the end coils. Electrically conducting shields were considered in this study. The model, a scaled-down version of a TGV-500 turbogenerator, was designed and built in accordance with space-time similitude requirements and with similitude of magnetic characteristics taken into account. Measurements and calculations were made with five design variants, to determine the maximum power loss density ( $W/cm^3$  per stack) as well as the total power losses in the press-on flange and in the shield. The basic variant I had a flat copper ring as a shield between stator core and flange. The shield in variant II had radial notches cut in line with the stator slots. The shield in variant III was placed on the outside of and tucked underneath the flange. The shield in variant IV was placed again between stator core and flange, but also tucked underneath the latter. The shield in variant V was a conical copper shell around the flange. The results indicate that variant IV is the most effective one. Both flange and shield operate most efficiently and reliably in this configuration. Power losses in the flange were calculated by Z. Kh. Borukayev, staff member at the Institute of Modeling Problems in Power Engineering, UkrSSR Academy of Sciences. Figures 5; tables 1; references 8: 7 Russian, 1 Western. [105-2415]

COST EFFECTIVENESS OF PRODUCING AND OPERATING NEW TYPES OF ELECTRIC POWER GENERATORS

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 82 (manuscript received 4 Dec 81)  
pp 58-61

KIRPICHEV, V. I., candidate of technical sciences, and VYRVINSKIY, V. V., candidate of economic sciences. VNIIelektromash (All-Union Scientific Research Institute of Electrical Machine Building)

[Abstract] The economic effect of producing and operating new or improved types of turbogenerators and hydrogenerators is analyzed from the user's stand-point, including not only the cost of new auxiliary equipment but also the indirect cost of novelty in relation to existing technology and service level. Included also are the costs of scientific research and experimental engineering. Three categories of new generators are distinguished: 1) Fundamentally new ones never before used in the Soviet Union and not analogous to any now used; 2) Generators intended for replacement of existing ones; 3) Additions to existing parametric series as intermediate or larger sizes. Calculation of all applicable fixed and variable cost components yields the break-even characteristics. Typical numerical data are shown on evaluation of a new 300 MW turbogenerator against an existing unit as reference base. Tables 1; references: 7 Russian.

[104-2415]

MEASUREMENTS OF INPUT CAPACITANCE OF 35-750 kV TRANSFORMERS AND REACTORS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 82 pp 60-61

VOL'POV, K. D., engineer, SOZINOV, A. V., engineer, KHALILOV, F. Kh., candidate of technical sciences, Donbass Power System Administration--Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] The input capacitance of 6-10/35 kV, 6-10/110 kV, 24/330 kV transformers (12 models), 15-75/220 kV, 35/500 kV, 15-75/750 kV autotransformers (8 models), and 500-750 kV shunting reactors (3 models) was measured, for the purpose of refining the design of lightning protection for high-voltage transmission lines. The results yield a mean equivalent input capacitance proportional to the fourth-power root of the three-phase MVA rating for the autotransformers and the shunting reactors, also for 500-750 kV transformers, and proportional to the third-power root of the three-phase MVA rating for the 35-110 kV transformers. It is  $C_{eq} = 4200-4900$  pF for the autotransformers and  $C_{eq} = 1600-2300$  pF for 220 kV transformers. The empirical coefficient K in the  $C_{eq} = K \sqrt[n]{MVA}$  relation is 800-940 for 500-750 kV transformers, 350-540 for 35-110 kV transformers, and 470 for shunting reactors

regardless of voltage class. Grounding affects the input capacitance to the extent that the latter is, in the case of transformers, 20% higher on the average, and up to 30% with grounded than with isolated neutral. Figures 2; tables 1; references: 4 Russian.  
[114-2415]

UDC 621.314.212.027

## METHODS OF EVALUATING RESULTS OF PROLONGED INSULATION TESTS ON ULTRAHIGH-VOLTAGE POWER TRANSFORMERS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 82 (manuscript received 15 Apr 81, after completion 10 Feb 82) pp 1229-1235

GORBUNTSOV, ALEKSANDR FEDOROVICH, deputy chief engineer, GURIN, VITALIY VASIL'YEVICH, candidate of technical sciences, section chief, and MAYAKOV, VLADIMIR PETROVICH, chief of laboratory, Industrial Association "Zaporozhtransformator", Zaporozhye

[Abstract] Prolonged high-voltage industrial-frequency (50 Hz) insulation tests of high-voltage (220+ kV) transformers and autotransformers have been conducted by the Industrial Association "Zaporozhtransformator" sporadically since 1965 and systematically since 1975. The test procedure was formalized in GOvernment STandard 21023-75 and subsequently supplemented in GOvernment STandard 22756-77. The basis test mode is under no load with simultaneous excitation of either two or all three phases by voltages 1.4-1.5 times the maximum operating voltage, for 1 h (standard periodic and routine tests) or at least 30 min (delivery tests) immediately after the 1-min test without prior reduction of the test voltage to zero. The important data, basis for transformer acceptance or rejection, are symptoms of insulation breakdown and location of partial discharges. In a pilot series, 500 ultrahigh-voltage (350-1150 kV) transformers were tested over a period of 1-2 years. The results have been evaluated according to a special program for data processing, with the intensity of partial discharges as criterion: 1) Transformer acceptable when  $q \leq 3 \cdot 10^{-10} \text{ C}$  (50 dB); 2) Transformer additionally tested when  $3 \cdot 10^{-10} \text{ C} < q \leq 3 \cdot 10^{-9} \text{ C}$ ; and 3) Sources of partial discharges sought, preferably by electroacoustic methods, and their dynamics analyzed for either acceptance or rejection depending on, respectively, safe or unsafe location of these sources when  $3 \cdot 10^{-9} \text{ C} < q \leq 10^{-8} \text{ C}$ . A charge of  $q_0 = 3 \cdot 10^{-10} \text{ C}$  thus serves as a ceiling level for unconditional acceptance,  $q_1 = 3 \cdot 10^{-9} \text{ C}$  (70 dB) and  $q_2 = 10^{-8} \text{ C}$  (80 dB) define the range for reconsideration, and  $q_3 = 10^{-8} \text{ C}$  (80 dB) is the threshold of unconditional rejection pending removal (if possible) of the sources of partial discharge. Figures 3; references: 8 Russian.

UDC 621.315.1.027.89

TRANSMISSION OF ELECTRIC ENERGY OVER 1150 kV EKIBASTUZ-URAL LINE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 10, Oct 82 pp 57-63

VISHNYAKOV, G. K., engineer, and SMIRNOV, B. I., engineer, Department of Long-Distance Transmission, All-Union State Planning, Surveying and Scientific Research Institute of Power Systems and Electric Power Networks

[Abstract] Design of the 1150 kV A.C. Ekibastuz-Chelyabinsk electric power transmission line was completed in 1981. It provides for dumping excess power to the western regions of Kazakhstan. The transmission system includes four 1150/500 kV substations: Ekibastuz, Kokchetav, Kustanay, and Chelyabinsk. Large blocks of 500 kV power are tapped from the latter two and appropriate compensating equipment is installed there. High capacity of this line is ensured by use of either 1150 kV - 900 MVA synchronous capacitors and shunting reactors or 500 kV - 450 MVA static thyristor-type compensators. The latter can be installed in the earlier stage. They facilitate single-phase automatic reclosing and reduce power losses, but they are not yet available. Provisions have been made for programmatic disconnecting of all three phases after unsuccessful single-phase reclosing, also for high-speed automatic reclosing. All transmission poles carrying PS-300 and PS-400 isolator chains are erected, with support guys, on mushroom-shaped reinforced-concrete footings. The substations contain adequate high-voltage and medium-voltage distribution equipment, with selective protective relaying equipment, connected in the "four thirds" scheme, or in the busbar-transformer with "two thirds" scheme, or in combination of both schemes. The circuit breakers are arranged either in two rows or between phases. In the latter case the disconnect switches can be suspended overhead or mounted on telescopic supports. All substation equipment is controlled from a mosaic panel which has been designed with the minimum number as well as length and diameter of cable connections from current transformers and potential transformers to relays. Figures 7.

[120-2415]

UDC 621.315.1.001.24

MEASUREMENTS AND CALCULATIONS OF PARAMETERS OF HIGH-FREQUENCY CHANNEL ALONG UNGROUNDED CABLE OF 220 kV TWO-CIRCUIT OVERHEAD TRANSMISSION LINE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 82 pp 52-54

ZAKRUZHNYY, E. G., engineer, Far Eastern Engineering Administration of Power Systems

[Abstract] The two-circuit 184.8 km long Tynda - Serebryanyy Bor 220 kV overhead transmission line runs over a territory mainly 480-600 m above sea level, the highest point having an elevation of 1100 m. Its AS-300/39 conductors are spaced vertically with transpositions at three points along the

route. They are installed on U38M anchor poles and P27M intermediate poles. The line includes a 184-9 km long lightning protective cable which is at each end connected to ground through two 50 Hz VZ-1000 reactor coils in series, two SMM-20  $\sqrt{3}$ -0.035 communication capacitors in series, and an FPU-17500 filter. Prior to startup, this cable was tested for absence of open circuits and short circuits to ground. Also measured was its input impedance and the attenuation of its high-frequency channel over the 30-300 kHz frequency range. Impedance measurements were made by the voltmeter-milliammeter method. Attenuation measurements were made first with all lines under voltage and then with both circuits disconnected from the substation busbars and grounded at both ends. The measurements were compared with theoretical calculations for a seven-conductor two-circuit Y-line with lightning protective cable. Experimental and theoretical data were processed on a computer according to a special program written in ALGOL-60. The results of this study reveal that transmission poles influence the input impedance as well as the attenuation of the high-frequency channel insignificantly at frequencies up to 36 kHz but quite appreciably at frequencies above 36 kHz, adding typically 16.0 dB attenuation at 200 kHz. Figures 6; references: 4 Russian.  
[114-2415]

UDC 621.316.1.019.34.001.24

#### RELIABILITY CALCULATION OF ELECTRIC POWER SUPPLY SYSTEMS

Moscow ELEKTRICHESTVO in Russian No 8, Aug 82 (manuscript received 26 Jun 80) pp 5-10

FOKIN, Yu. A., candidate of technical sciences, and KHARCHENKO, A. M., engineer, Moscow Power Engineering Institute

[Abstract] In a 1978 paper by Yu. A. Fokin and A. M. Kharchenko (see above), as applied to calculations on a digital computer, methods are considered for formalization of obtaining circuit designs with respect to reliability, taking account of the logic of functioning of electrical circuits. The present paper discusses a farther development of this approach. Its distinctive feature is the separation of a problem based on the formalization process of obtaining circuit designs with respect to reliability in simple and obvious form, and calculation of reliability indices. In so doing the principal electrical circuit is used as the initial information. A more precise method and an approximate method are presented for formalization of the process of composition of calculated circuits with respect to reliability. Algorithms take into account the special features of the logic of functioning of electrical circuits of electric power supply systems. Figures 2; references: 6 Russian.

[27-6415]

UDC 621.316.925.2.019.3.001.24

CALCULATED EVALUATION OF RELAY PROTECTION RELIABILITY

Moscow ELEKTRICHESTVO in Russian No 8, Aug 82 (manuscript received 12 Jan 82) pp 34-39

VAVIN, N. V., engineer, Moscow

[Abstract] The paper proposes criteria for the reliability of functioning of relay protection (RZ) systems, as well as a method for determination of reliability indices. At present the new method considered is widely used for calculations of reliability during planning of anti-emergency (PA) systems. It is also used for particular calculations of RZ. The paper concludes that the simplicity and sufficiently high precision of this method creates prospects for its farther introduction into the practice of planning and operation of RZ and PA systems. It is used during composition of standard methods of calculations of RZ devices. These are issued by "Energoset'proyekt" (All-Union State Planning, Surveying and Scientific Research Institute of Power Systems and Electric Power Networks). Figures 2; references: 2 Russian.  
[27-6415]

UDC 621.316.925.45

DISTANCE PROTECTION AND ONE-WAY DETERMINATION OF FAULT LOCATION

Moscow ELEKTRICHESTVO in Russian No 8, Aug 82 (manuscript received 23 Sep 81) pp 29-34

ARZHANNIKOV, Ye. A., candidate of technical sciences, Ivanov

[Abstract] The paper considers the theoretical feasibility of eliminating as far as possible the effect of contact resistance during distant protection and determination of fault location. The investigation was conducted for the simplest case, i.e., a line with a two-way feed without bypass linkage with neglect of transverse conduction. In addition, a number of assumptions are made. These are: 1) Contact resistance is linearly and purely active; 2) Aperiodic and higher harmonic components in currents and voltages are absent; 3) The parameters are precisely known of a line and system in a circuit of zero order (for devices operating with a short circuit to earth) or in a circuit with a reverse sequence. It is shown that on the basis of a calculation of the reactive impedance up to the location of a short circuit, it is possible to achieve both distant protection of the line and one-way determination of fault locations. Use can be made of corresponding devices. Figures 7; references: 3 Russian.  
[27-6415]

MAGNETIC REPEATER FOR CURRENT MEASUREMENT IN HIGH-VOLTAGE POWER LINE

Moscow ELEKTRICHESTVO in Russian No 8, Aug 82 (manuscript received 16 Dec 81)  
pp 50-52

MEYEROVICH, E. A., KARABAYEV, G. Kh. and BARYSHEV, V. I., ENIN (Energy Institute imeni G. M. Krzhizhanovskiy)

[Abstract] The report describes a magnetic repeater (MR) for measurement of currents in individual conductors and wave channels. The MR is used in devices for relay protection and automatics. Constructively, the MR is fulfilled on the basis of integrated circuits and discrete semiconductor devices. It is shown that by virtue of the compensation principle incorporated into the basis of operation of the MR, the latter possesses a substantial range of linear measurement. This is large in comparison with the noise immunity of magnetic-sensitivity elements (ME). The precision of measurement of a field practically does not depend on the temperature of the surrounding medium. A device on the basis of a MR, for distant measurement of the currents of a high-voltage line, makes it possible precisely and inertialessly to transmit a curve of the current being measured in the frequency range from 0.02 to 10 kHz.

Figures 6; references: 4 Russian.

[27-6415]

SERIES OF SMALL INDUCTION MOTORS

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 5, Sep-Oct 82 pp 3-4

BEKERIS, I. P., GERSAMIYA, E. G. and KISLENKO, V. I.

[Abstract] A new series of general-purpose single-phase induction motors with power ratings from 0.6 to 180 W, the first such series to be produced in the Soviet Union, has been developed jointly by the Vilnius branch of the All-Union Scientific Research, Design Engineering and Technological Institute of Small Electric Machines (VNIIMEM) and the All-Union Scientific Research and Design Engineering Institute of Technology of Low-Power Electric Machines (BNIITME). The Institute of Electrodynamics at the UkrSSR Academy of Sciences, the Moscow Institute of Power Engineering, the Kaunas Polytechnic Institute imeni A. Smechkus, and other organizations also participated in the development. The series encompasses motors with distributed stator windings and motors with concentrated stator windings, as well as motors with asymmetric stator cores. They feature 15-30% higher starting and pull-out torques than motors now produced, with a 7-12% smaller amount of active material. Their applications include instruments, computers, duplicators, medical equipment, kinematographic equipment, and various home appliances. They are being put in production at plants of the Ministry of Electrotechnical Industry. Series production of motors with concentrated stator windings alone should cover the 1985 demand for such motors at a saving of 5.2 million rubles. Figures 1.

[105-2415]

## PARTICULARS OF INSTALLING, REGULATING AND ADJUSTING 750-kV AIR BREAKERS

Moscow ENERGETIK in Russian No 6, Jun 82 pp 19-21

PLEKHANOV, V. M. and KONOVALOV, Z. A., engineers, Long-Distance Electric Power Transmission Production Association, Moscow

[Abstract] Air breakers type VVB-750-35 (developed by Elektroapparat Plant) and VV-750 (developed by Uralelektryazhmarsh Plant) were installed on the first experimental 750 kV transmission line between Konakovo and Moscow in 1967. In recent years the manufacturers have made design changes in these breakers and improved their technical characteristics. For example the rated tripping current has been increased from 27 to 40 kA, and clearing time has been cut in half. The control circuit of the VVB-750-40/3200 considerably increases the speed of the breaker as compared with the VVB-750-35. The present article gives the particulars of installing, regulating and adjusting VVB-750-40/3200 and VNV-750 air breakers. The use of a new modification of series VVBK quenching chambers with improved switching capabilities in the 750-kV breaker will reduce installation time by a factor of 1.3. To reduce the time for adjustment of VVB-750-40/3200 breakers, the chambers should be regulated on the plant stand in assembly for each individual component of a pole without installing the supporting insulation. Stability and accuracy of operation of the VVB-750-40/3200 breaker in the engagement-tripping cycle depends on the parameters of the engaging pulse. It would be advisable to include in the specifications a time range of 150-155 ms for the engaging pulse. Intersystem connections between VNV-750 air breakers in substations would shorten the time of installing, regulating and adjusting 750-kV open-air distribution systems. Implementation of the recommended steps should cut the costs of adjustment work on 750-kV air breakers in half. Figures 2; tables 2.

[64-6610]

UDC 621.313.323-133

## PECULIARITIES OF DYNAMICS OF FLAT ELECTRIC STEPPER MOTOR

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 82 (manuscript received 14 Jun 82) pp 1241-1246

PRUDNIKOVA, YULIYA IVANOVNA, engineer, and POPOVICH, YELENA ANDREYEVNA, candidate of technical sciences, senior scientist Moscow Power Engineering Institute.

[Abstract] Electric precision XY-drives with flat stepper motors are used in digital programmed control for effecting motion in a Cartesian system of coordinates. The dynamic performance of such motors was calculated in a study based on a mathematical model with seven differential equations describing the physical processes in the motor as well as the transient response of its mechanical and electrical systems. The algorithm of calculations applicable to any geometry of the XY-drive, has been programmed for a digital computer,

with allowance for wide variation of the design parameters (slot width, tooth height, armature core and inductor length, maximum X-travel and Y-travel of armature). The computer experiment covered electrical and mechanical input perturbations acting first successively, then simultaneously in a manner most severe from the standpoint of stability. The results reveal that most threatening to stability is external perturbation of armature rotation which appears simultaneously with a signal for the next step along X and Y axes. Oscillations can be reduced and the stability limit thus raised by increasing the ratio of natural frequency of angular oscillations to natural frequency of linear oscillations, by increasing the viscosity in angular motion and decreasing the viscosity in linear motion along both coordinates. A critical level of perturbations exists, above which armature displacements along both coordinates change drastically and become uncontrollable. Figures 6; references: 2 Russian.

[121-2415]

QUANTUM ELECTRONICS/ELECTRO-OPTICS

UDC 537.533.3

TWO-BEAM LINEAR HIGH-VOLTAGE ELECTRON-OPTICAL SYSTEM WITH CENTRIFUGAL-ELECTROSTATIC BEAM SHAPING AND WITH RECUPERATION OF ELECTRON ENERGY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 16 Nov 81) pp 2222-2225

ANDRIKANIS, L. I., BUNINA, N. S. and MELIKOV, M. Z.

[Abstract] A linear electron-optical system with centrifugal-electrostatic shaping of electron ribbon beams has been designed, built, and tested. It is a two-beam device consisting of a wide shaping electrode at one end, two cathode-anode pairs adjacent to it, each cathode inside a modulator, and a wide collector at the other end with a protective electrode between the two beams. The field inside this device has been mapped, with electron trajectories and equipotential lines plotted for the conditions of current flow (electrode commutation voltages  $V_{shap} = 0$ ,  $V_{anode, modul} = 6$  kV,  $V_{coll} = 1.8$  kV) and current cutoff (electrode commutation voltages  $V_{shap} = -5$  kV,  $V_{anode, modul} = -5$  kV,  $V_{coll} = 250$  kV), respectively. The perveance of the device, per unit cathode length and referred to the collector potential is  $P = 2.5 \cdot 10^{-6}$  A/(V $\frac{3}{2}$  cm). Measurements indicate that as the collector potential (referred to anode potential) increases, the anode current decreases linearly, the collector current increases linearly, and the cathode current (anode current + collector current) remains constant at approximately 325 mA. The distribution of minimum potential along the collector, measured with an electron probe, indicates a high effectiveness of the protective electrode. The experimental data agree closely with theoretical calculations. Figures 5; references: 4 Russian.  
[116-2415]

UDC 621.373.826

THERMAL SELF-EFFECT IN BEAM OF CONTINUOUS-WAVE CO<sub>2</sub> LASER DURING INTERACTION WITH AQUEOUS AEROSOL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 7 Sep 81) pp 2162-2166

ARMAND, S. A., BISYARIN, V. P., YEFREMENKO, V. V., KOLOSOV, M. A. and KORNILOV, L. N.

[Abstract] An experimental study was made of thermal self-focusing of a continuous-wave CO<sub>2</sub> laser beam propagating through evaporating aqueous aerosol. A method was used allowing direct measurement of the beam divergence angle at the exit from the interaction space. The equipment included an auxiliary He-Ne laser with a beam parallel to the main laser beam for measuring, at the 0.63  $\mu$ m wavelength, the optical thickness of the water mist along the path, two wattmeters for power measurement before the entrance to and behind the exit from the fog chamber, two light splitting NaCl plates, a 0.63 micrometer filter, a bolometer for measuring the intensity of the He-Ne laser beam and two bolometers (each a pair of orthogonal wire meshes) for measuring the cross section and the intensity profile of the main laser beam, with a multichannel digital indicating instrument and a recording instrument. The results, compared with theoretical estimates, reveal that, as the initial optical thickness of the aerosol increases, both the exit divergence angle of the laser beam and the change in optical thickness of the aerosol increase at first almost linearly and then at a decreasing rate. After having reached their respective maxima, they decrease. This nonlinearity is probably caused by unequal attenuation of the laser beam at the center and at the periphery. Figures 3; references 12: 10 Russian, 2 Western.

[116-2415]

UDC 621.375.8.029.65

TRAVELING-WAVE ANDALUSITE MASERS FOR MIDDLE MILLIMETER WAVEBAND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 9, Sep 82  
(manuscript received 30 Dec 80) pp 1804-1812

CHERPAK, N. T., SMIRNOVA, T. A., MYSHENKO, V. V., PESKOVATSKIY, S. A. and LAVRINOVICH, A. A.

[Abstract] The feasibility of a traveling-wave maser amplifier for the middle millimeter waveband (35-75 GHz) on an andalusite crystal (Al<sub>2</sub>SiO<sub>5</sub>:Fe<sup>3+</sup>) is examined, considering the superior properties of this crystal for such an application. The basic relation for the gain is expressed in a form most suitable for analysis. The dependence of signal and pump frequencies as well as of the transition probability matrix on the magnetic field intensity is calculated for an active crystal with transverse three-level pumping, also the

frequency dependence of the negative magnetic decrement and of the loss decrement in the retarding structure. The results are compared with experimental data on a retarding structure and quantum 1-2 transitions in the electron-paramagnetic-resonance spectrum of  $\text{Al}_2\text{SiO}_5:\text{Fe}^{3+}$  and in the ferro-magnetic-resonance spectrum of various hexaferrite crystals, at temperatures within the 1.7-4.2 K range. Stability of operation is ensured by elimination of regenerative effects and providing for this purpose a nonreciprocal element which absorbs reflected waves. The amplifier includes also a superconducting magnet with power supply, a Mach-Zender interferometer, and a pumping source with power supply. Its performance characteristics are better than those of such an amplifier built on a ruby crystal. Its tuning range can be widened by increasing the transition slowdown, the crystal length, and the non-uniformity of the static magnetic field. It should also be feasible to produce such a maser for shorter waves (down to  $\lambda = 4$  mm, 35-75 GHz). The authors thank V. P. Shestopalov for suggesting the use of a diffraction radiation generator as a pumping source, B. K. Skrynik and I. D. Revin for constructing the various pumping sources for the experiment, also D. Ye. Gromzin, V. K. Kunevich, and V. M. Osnos for designing and constructing the wideband rectifiers and circulators for operation at liquid-helium temperatures, and V. I. Ivanova and I. I. Petrova for producing and delivering the batch of hexaferrites. Figures 6; tables 1; references 28: 19 Russian, 9 Western.  
[103-2415]

SOLID STATE CIRCUITS

UDC 621.382.3

MAGNETOSENSITIVITY CHARACTERISTICS OF INTEGRATED CIRCUIT COMPONENTS WITH CHARGE INJECTION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 11, Nov 82  
(manuscript received 20 Jan 81) pp 2230-2234

VIKULIN, I. M., GLAUBERMAN, M. A. and KANISHCHEVA, N. A.

[Abstract] An experimental study was made of a planar two-collector magnetotransistor with charge injection through the emitter and of its performance characteristics as component of integrated circuits, operation of this device essentially involving redistribution of the magnetic field of injected electrons between the two collectors. A pair of complementary amplifier transistors was built into the collector junctions of this device in order to further increase the already high magnetosensitivity. The two collector currents of the amplifier transistor pair were measured as functions of the injection current. These two collector currents and the two collector currents of the magnetotransistor stage as well as both current and voltage sensitivity of the integral device to changes in the magnetic field intensity were measured as functions of the magnetic field intensity level. Their dependence on the magnetic field intensity is characterized by a threshold and a subsequent peak at some higher magnetic field intensity. The results, based on a lot of 50 samples with a variance of the parameters not exceeding 12%, indicate that the magnetosensitivity of such devices can be increased further by maximizing the gain of one amplifier transistor so that the difference between the currents of both amplifier transistors will change maximally. Figures 5; references: 4 Russian.  
[116-2415]

UDC 621.382.047

INPUT STAGES OF CHARGE-COUPLED DEVICES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 12, Dec 82  
(manuscript received 21 Sep 81) pp 2280-2309

TRISHENKOV, M. A. and VINETSKIY, Yu. R.

[Abstract] The input stage of a charge-coupled device converts an electric input signal to a charge which is transmitted to the following stages. The

input stage, therefore, contains a drain and a source separated by a gate constituting a potential barrier. The structure is essentially that of a field-effect transistor, typically with a MOS gate and a MOS drain and either a diffusion region (p-n junction) or a MOS cell as source. The role of the input signal is, similarly, to modulate the operating source-drain current while the electrode potentials either remain constant (stationary method) or may vary (nonstationary method). In the latter case the gate potential and the drain potential tracking the source potential and the surface potentials of both regions tending to become balanced. In either case the input signal lowers the source-gate barrier potential and proportionally also the source charge, a part of the latter being transferred through the gate to the drain. As the basis of further performance analysis are calculated first the charge carrier concentrations in the source region and in the gate region under equilibrium conditions (both regions with the same Fermi quasi-level and no current flow) and then the current-voltage characteristics. The current is calculated from the equation of hole transfer, the solution to which for the appropriate boundary conditions confirms the existence of a threshold below which the current depends on diffusion and above which the current depends on drift in the self-induced field. On this basis are derived equivalent circuits of the input stage corresponding to its operation in the constant-current constant-voltage mode or in the "floating surface potential" mode. Various electrode configurations and structure topologies are used in the basic design, the performance parameters and characteristics varying accordingly. Special features such as feedback (negative or positive) and shunting capacitors are added for enhancement of desirable or suppression of undesirable effects under conditions where this is possible. Developments for the purpose of optimization, especially with respect to sensitivity, inertia, and noise, mainly through experimental studies, include search for other than MOS source and gate structures. Figures 8; references 35: 5 Russian, 30 Western (4 in translation).

[117-2415]

SONICS & ULTRASONICS

UDC 539.216.22

GENERATION AND ABSORPTION OF HYPERSOUND IN THIN FILMS OF ZINC SELENIDE

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82  
(manuscript received 17 Dec 81) pp 418-423

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[Abstract] Some results are presented of an investigation of the piezoelectric and elastic properties of zinc selenide. The amplitude-frequency characteristics are investigated of electroacoustic transducers based on grain-oriented ZnSe films. The structure of the ZnSe films is studied by X-ray, electron and metallorgraphic methods, and the methods of obtaining the films is explained. The propagation velocity of longitudinal and transverse waves in straight-line ZnSe textures are measured. The velocities of sound in the films does not differ from their values in monocrystals of corresponding orientation (III). The absorption of longitudinal and transverse hypersound waves in ZnSe films from 2 to 20 micrometer is measured in the frequency range  $1.10^8$ - $2.7 \cdot 10^9$  Hertz. The results obtained show that films of ZnSe can be successfully used in optoelectronic and acoustoelectronic devices for processing information. Figures 4; references 13: 10 Russian, 3 Western (1 in translation).

[24-6514]

UDC 621.382

INTERACTION OF ACOUSTIC SURFACE WAVES WITH CHARGE CARRIERS IN CHANNEL OF FIELD-EFFECT TRANSISTOR

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 5, Sep-Oct 82 (manuscript received 7 Jan 80) pp 473-477

BUFF, V., TISHMEYER, R. and YAKOVKIN, I. B., Institute of Semiconductor Physics, Siberian Branch, USSR Academy of Sciences

[Abstract] This brief communication discusses the effect of acoustic surface waves (ASW) on the operation of a field-effect transistor. Use of this effect

reveals the possibility of constructing new types of devices which unit in themselves the advantages of acoustoelectronics and microelectronics. The following points are considered and illustrated: 1) Effect of constant compressive stress on output characteristics of MOS transistors; 2) Experimental device for investigation of MOS-transistors; 3) Block diagram of experimental device for determining the conversion losses of surface waves; 4) Dependence of conversion losses of ASW on the magnitude of current in MOS-transistor channel; 5) Oscillogram of probing signal and converted field-effect transistor; 6) Effect of conversion of ACW on oriented silicon substrate as a function of azimuthal angle  $\alpha$ ; and 7) a. Input and output signals of one transistor; and b. Results of interference signal with two MOS-transistors. Figures 7; references: 4 Western.  
[24-6415]

CSO: 1860

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